5 Case studies

"Economic enterprise consists in the matching of resources and opportunities to create value...A sequence of phases in the early life of the firm reflects growth processes and problems, solutions giving rise to new problems. Firms must access, mobilise and deploy resources before they can generate resources for growth...The growth of the firm is related to the building of the competence needed to respond to changing industrial opportunities" (Garnsey, 1998:523).

This chapter uses the example of five firms in the Australian biotechnology industry to provide an outline of the first three early growth phases outlined in the Garnsey (1998) model. Summaries of the problems encountered by each firm in each phase of its growth are presented in table form. Extended case descriptions are presented in the appendices.

The companies are discussed in five separate sections: Cochlear Limited (Section 5.1); Novogen Limited (Section 5.2); BTF (Section 5.3); Proteome Systems Limited (Section 5.4); and Cotton Seed Distributors (Section 5.5).

The three growth stages being examined are the Resource Access Phase, the Resource Mobilisation Phase and the Resource Generation Phase. The Resource Access (or prospecting) Phase of the firm's growth process comprises the discovery component of the value chain. The solutions to the Resource Access Phase lead to new problems in the Mobilisation Phase, which includes problems concerning business plans and strategies, long term financial resources, manufacturing issues and developing appropriate company structure. Overcoming these problems enables the company to progress to the Generation Phase, where problems revolve around bottlenecks in the production process, marketing issues and incorporating new firm members.

The progression of each firm through each phase is not linear. A number of organisational and environmental factors complicate each company's ability to mobilise their resources. These include an inability to source local financial resources, local institutional problems and the inability of scientific entrepreneurs to appreciate the level

of commercial expertise required for successful commercial outcomes. These facets are discussed in turn for each firm. It is argued that growth is not only path dependent, but that timing and serendipity play a major role in the uncertainty associated with such evolutionary development. The conclusion therefore cannot be prescriptive. The historical context is presented here to show possible outcomes to growth constraints, in order to provide entrepreneurs with an opportunity to develop mitigating strategies by anticipating such problems before they occur.

5.1 Cochlear Limited

Cochlear Limited, a medical device company, manufactures a device which, when implanted into the cochlea, produces electrical stimulation to the hearing nerves enabling a profoundly deaf person to hear. Its competitive advantage is its multi-channel application that enables a profoundly deaf person to distinguish language without assistance from lip reading or other visual cues. Single-channel cochlear implants have not been able to match the same level of delivery to the patient.

The case study was compiled from a substantial body of publicly available material (Clark et al., 1987; Roulleau & Matha, 1989; Haggard, 1991; House & Berliner, 1991; Mecklenburg & and Lehnhardt, 1991; Vandermerwe, 1991, 1993; Smith, 1999; Clark, 2000; Hirshorn, 2002) and eight personal interviews. The interviews were conducted with Michael Hirshorn, Chief Executive, Nanyang Ventures; David Money, former CEO Cochlear, retired; Jim Patrick, Senior Vice President and Chief Scientist, Cochlear; Ron West, former President US subsidiary, retired; Monika Lehnhardt, CEO European Division, retired; Rae Reynolds, First Marketing Manager, US subsidiary; Dianne Mecklenburg, Cochlear consultant, US and Europe; and Sue Roberts, Marketing, European Division. Additional material was obtained from interviews conducted by Martin Gibb, researcher, Melbourne University, with David Money and Paul Trainor in 1999. A detailed description of the Cochlear Ltd case study is presented in Appendix 1.

5.1.1 Resource Access Phase

The Resource Access Phase in the biotechnology industry represents the discovery component of the value chain, where activities centre on idea generation, idea evaluation, feasibility of concepts and proof of principle. It is not until the proof of principle has been achieved that the project can move into the development phase, where activities centre around testing for commercial possibilities.

This thesis proposes that in line with the Garnsey (1998) model, four critical problem areas can inhibit the progress of the biotechnology project to the Mobilisation Phase. These variables include the market aspirations and attitudes of entrepreneurial scientists as outlined by Schumpeter in 1934; the feasibility of the technology; the availability of financial resources; and the institutional environment. The case study addresses each of these variables in turn, outlining the critical activity that provided solutions to each of these possible problem areas.

(i) Entrepreneur

Professor Graeme Clark resolved to become an ear doctor while working in his hearing impaired father's pharmacy. This resolve initially led him to pursue the study of medicine in 1952 at the University of Sydney. His journey into the functioning of the brain began in 1960 at the Royal Prince Alfred Hospital in Sydney, where he worked as a registrar in brain surgery. His experience in this position provided him with insights that later helped him develop surgery procedures to drill through the skull to the lining of the brain to make a deep enough bed for the implantable device. Thus began a 10-year journey where he built competence, eventually becoming the foundation professor of the Chair of Otorhinolaryngology (ear, nose and throat (ENT) surgery) at Melbourne University. His view of the opportunity to improve the quality of life for the hearing impaired became a demonstrated reality with the implant of what was initially called the bionic ear into three patients in Melbourne in 1978.

Clark was convinced at an early age that he could improve the quality of life for the deaf. He was not interested in developing pure scientific theory. He was driven to produce a market product, although it was for altruistic and not commercial reasons.

Having established his surgical credentials, he drove the surgical research on hearing response of the brain by drawing on his expertise in intensive neurosurgery. Throughout 1971–1972 he brought together an able group of postgraduate students who were actively engaged in research to establish whether the rate of stimulation on a single electrode would be adequate for speech understanding. This line of research challenged the concept of single-channel devices, and by 1973 it was clear that electrical stimulation on a single electrode would not reproduce speech frequencies. This finding resulted in Cochlear Limited producing a multi-channel device that eventually gave it the leading competitive edge in the cochlea implant industry.

Clark used his position as Head of Otorhinolaryngology at Melbourne University to obtain grants for essential equipment and laboratory facilities. In the conservative scientific community of the time he was unable to obtain critical research funding from available medical and research sources, and he needed to develop skills in raising funds from other sources. His competent presentation and persuasion skills enabled him to identify and inspire a group of research students, and also to inspire the general public to contribute to his cause and bring forward patients who were willing to be subjects for the untried surgical procedures. It also provided him with access to engineering academics who assisted with the bio-engineering skills he lacked. Table 5.1 opposite summarises the market aspirations of Cochlear's scientific entrepreneur, as discussed in this section.

(ii) Technology

The second section of the project was based on the more expensive area of electronic engineering. Clark had no background or experience in electronic engineering and turned to Dr David Dewhurst, a colleague in the Engineering Department, to help with the project to develop an electrical stimulator of the inner ear. Dewhurst in turn found a student, Ian Forster, who was interested in starting a PhD on developing a design for the electronics, but additional engineering help was anticipated to develop the package. This step was seen to be very tricky as the body contains very corrosive fluids that can penetrate through solder and cause electronic failure.

Critical Problem	How to use ten years of research experience to build on a scientific idea? How to convince conservative scientific colleagues the idea is not outrageous? How to substantiate research on neurological stimulation of the hearing nerve? How to extend passion for the idea to inspire research teams so that they work long hours for no pay – race to be first against better financed* overseas competition?
Critical Activity	Use position as Head of Otorhinolaryngology at MU to • Lead student teams to prove surgery possible • Prove multi-channel device superior over single channel Engineering Dept colleagues provide contacts to bio-engineering graduate Develop skills in fund raising to groups like Apex, Rotary & Felton Bequest Find suitable patients
Solution	Develop competence to; • Inspire dedicated multidisciplinary team to work for little pay to solve technical problems • Inspire public and scientific network for contributions and patients • Use untraded resources for essential facilities, equipment and salaries to complete project

Table 5.1: Resource Access Phase entrepreneurial challenges – Cochlear

The work was driven and managed by bioengineer Jim Patrick, a student of Dewhurst, who started work in January 1975. The team at that stage consisted of about ten of Clark's postgraduate students, a lab manager, researchers from the psychology department who were experimenting with the different sounds heard by cats when electrodes were placed in different locations in the cochlea, and others who were making single unit recordings putting the electrode right into a single nerve fibre or who were working on the spread of current. It was a small but very enthusiastic and energetic department, involved in a wide range of activities with researchers frequently working seven days a week for 12 hours or more. The team was driven by the science and the sense that what they did could make a

profound difference to patients – their research could make people hear who otherwise might never have heard a sound.

By 1977 the team designed and constructed the implant but it was necessary to drastically reduce its size. An apparently large amount of electronic circuitry had to fit into a very small space. Eventually the team created a sealed, gold plated box, covered with silicone rubber, and small enough to form the implantable unit.

Critical Problem	How convince conservative scientific community of the benefits of emerging technology? How to prove that the development of implant was possible? Where to find experts in software, Computing & audiology for the project? How to prove the superiority of Multi-channel device? How to build expensive bio-engineering & programming competence? What materials best to use? Where to find materials? How to make the computer small enough?
Critical Activity	Use students' experiments to prove that the multi-channel implant would be superior Develop safe surgical methods Inspire physicist colleague to assist with development of electronic stimulator Invite PhD student to design custom-made silicon chip Employ bioengineer graduate to design circuitry, coordinate research and solve problems with implantable device
Solution	Circuit design completed and tested successfully on bench then miniaturised Prove reliability Develop bundle of wires that can be inserted into the inner ear without causing damage to transfer the electronic current Develop appropriate tests for selecting suitable patients to demonstrate feasibility of the concept

Table 5.2: Resource Access Phase technological challenges – Cochlear

The entire development process included interdisciplinary teams of audiologists, bioengineers, speech and hearing therapists, psychologists, social workers and otologists on which the development of Clark's concept depended. Each step of the progress was an experiment built on the experiments that went before it. Table 5.2 summarises the technological development of Cochlear through its Access Phase.

(iii) Financial resources

Funding was always an issue. In the 1970s the US government was supporting medical research through their National Institute of Health. A great deal of funding was going to Stanford, UCSF and other implant research projects in the US. In Melbourne, the team was financially disadvantaged compared with their overseas competitors. One grant from the NHMRC for $5,214 was approved in the initial steps of the project. No more funding was approved from that body since the processes required peer reviews of the proposal and Clark's peers had no belief in his research. Funds for essential equipment were obtained from various voluntary sources, such as Rotary Clubs, Lions Clubs and the Apex Club of Melbourne. The award of a cheque for $2,000 by the Apex Club happened to be seen on the evening news by Reg Ansett, founder of Ansett Airways, who eventually provided access to telethons. Through these the team was able to collect close to $500,000, enabling it to extend the research to the development of a prototype. Table 5.3 summarises the financial issues in Cochlear's Access Phase.

Critical Problem	How to pay for all essential resources? MU not supportive of the concept => a reduction in grants funding Poorly/unpaid project – always working with uncertain budget How/where to obtain $75,000 funds for new computer?
Critical Activity	Obtain first grant from NHMRC by changing focus of submission Sell the idea to the public initially through personal appeals to voluntary groups such as Rotary Clubs then TV telethons Test patients pay $10,000 for their implants even though they can break down after six months
Solution	Gather sufficient financial resources to complete the development and testing of first prototype

Table 5.3: Resource Access Phase financial challenges – Cochlear

(iv) Environment

The positive publicity from the telethons helped to overcome the conservative nature of the scientific community and enhanced the ability of the project to access valuable assets. The publicity surrounding the telethons heightened public awareness, and profoundly deaf people were learning that a bionic ear might one day be able to help them hear. The Australian Association for Better Hearing, an organisation of people who mainly had hearing before going deaf, referred other potential research subjects and initial potential customers to Clark. Development of such networks resulted in the researchers identifying three people to become the first research subjects to test the prototype at the proof of concept stage of the innovation. Other contacts that Clark approached for assistance included Mr Malcolm Fraser, Prime Minister in 1978, and Bob Hawke, then the leader of the ACTU and later Prime Minister from 1983. These connections became valuable sources of support and funding. Table 5.4 summarises the environmental context in Cochlear's Access Phase, as discussed in this section.

Critical Problem	How to work within conservative MU scientific community? How to overcome unsatisfactory peer review of grant applications? Where to obtain equipment such as electronic stimulator unit and computer? How to develop micro-chip technology? How to overcome finance problems against global giants like 3M who increase support for overseas competitors?
Critical Activity	Build local & overseas network of ENT scientists to promote the work Maintain direction of multi-channel development Convince local public of practicality of project to gain financial, government and clinical support Market the potential of implant through TV telethons to reach possible patients who offered to be guinea pigs
Solution	Redirect expectations from sceptics to support Successfully implanting three deaf patients who demonstrate through testing that they can hear sound after their operations

Table 5.4: Resource Access Phase environmental challenges – Cochlear

Summary of Cochlear Limited Resources Access Phase

The Resource Access Phase of Cochlear's growth path has been viewed through four elements: the entrepreneur, the technology, the financial resources and the environment. The elements are interdependent and their interaction contributed to a successful outcome for this phase, where sufficient resources had been accessed to develop and test a prototype implant on several patients to proof of concept stage. The project could progress to the next phase.

According to the Garnsey (1998) model, the Access Phase is followed by the Mobilisation Phase, as described in Chapter 3. However, although all key aspects of the Access Phase had been accomplished, movement into the Mobilisation Phase could not yet commence. The Australian Government, seeking to encourage high-tech development, became part of the project's development. Tenders were requested from companies that could perform a market study and write a development cost plan for commercialisation. Although Telectronics/Nucleus eventually won the tender, for a period of time neither Clark nor Nucleus was in control of the project. This period had a major impact on the success of the project and therefore it has been included here as an additional phase, described as the Resource Access/Mobilisation Crossover Phase.

5.1.2 Resource Access/Mobilisation Crossover Phase

Although Clark and his researchers had developed a prototype that clearly demonstrated potential, there was no understanding of the extent of the market and commercial partners were not willing to undertake the expensive Mobilisation Phase. Also the university model was described by one possible partner as a work of art but not necessarily a product that could be manufactured with commercial returns. These two issues were addressed in this intermediate phase between resource access and mobilisation. In this phase the prototype was redesigned to enable commercial manufacturing and eventual regulatory approval. The Australian Government called for tenders from companies able to perform a market study and write a development cost plan for the commercialisation of the implant system. Nucleus Limited, an Australian medical devices company, won the tender.

Nucleus was a holding company that specialised in several medical devices. Telectronics, a company producing implantable pacemakers, operated under its umbrella. The pacemaker company had expertise in implantable devices and understood the concept of hermetic sealing to eliminate leakage. It also had a global infrastructure on which to build the new company that was eventually named Cochlear Limited.

The view of Telectronics/Nucleus was that the market should be considered in a global context, rather than marketing first in Australia and then expanding internationally if the local market was successful. The government grant provided the means with which to conduct such an expensive exercise.

Critical Problem	Is there a market? Is the development feasible? What will the market pay? Where to begin the tests? How to train overseas surgeons/audiologists/ technicians?
Critical Activity	Use government funding to undertake global market study Redesign prototype to determine cost of commercial production Successfully implant eight additional patients to prove new design for FDA clinical trials Extend scientific/medical network to champion new device
Solution	Market study confirms extensive global market Commercial partner draws on technical skill and global structure of sister company Knowledge transfer from MU Extended trial with six patients Develop business plan

Table 5.5: Summary of Resource Access/Mobilisation Crossover Phase – Cochlear

Manufacturing issues included the ability to redesign the complicated prototype to a commercially manufacturable stage. The initial implant had approximately 55–60 integrated circuits within the hybrid package, which was unmanageable from a manufacturing point of view. Clearly Telectronics could not use the Melbourne University prototype. Research would need to start again, building on what the

university team had learnt while making their device. The government funding program allowed only a short time for development, which increased the tension of redesigning the device. The commercial team asked Clark to allow Patrick and a number of other Melbourne University team members to join their team to facilitate a speedy outcome and a crossover stage between the Resource Access Phase and Resource Mobilisation Phase began. Table 5.5 summarises this crossover phase.

5.1.3 Resource Mobilisation Phase

This phase of the case study involves the conversion of assets assembled in Phase I to generate resources. It focuses on the development of the redesigned prototype to gain regulatory approval through US FDA clinical trials, needed before the company could progress to production scale up and marketing. Cochlear had been more fortunate than most biotech companies in receiving government support to determine market demand and commercial viability of a university developed prototype before it committed to the Mobilisation Phase of growth. For this reason the Mobilisation Phase for Cochlear was much shorter than for the other four cases. The Mobilisation Phase comprised four elements: developing business strategies; solving long-term financial and manufacturing issues; and building appropriate organisational structures so the company could reach break-even point and begin to make profits.

(i) Developing business strategies and commercial expertise

Once the market study had identified sufficient world-wide demand to justify manufacture, the company moved into its next phase of mobilising its resources in an effort to commercialise the prototype and sell it on the global market. David Money, the first CEO, was aware of the issues facing the company in reaching its growth objective. At that time pacemakers were the only commercially successful implantable electronic device, and Money knew that a reliable product that was fast to market, made honest claims and had a realistic price would ensure continued success. His strategy was to licence the IP from Melbourne University and, jointly with MU and Telectronics experts, to manufacture the implant in Sydney for the final stage FDA trials.

It was deemed essential for the trials to be conducted in the US. Mecklenburg (Cochlear's US and Europe consultant) was sent to there to select suitable centres and surgical teams who would be able to manage people for lengthy rehabilitation sessions. Hirshorn (Chief Executive, Nanyang Ventures) was charged with the responsibility of promoting the Melbourne/Nucleus device to a market that did not always recognise or necessarily trust Australian scientific excellence. Mecklenburg and Hirshorn recognised they were negotiating in a market suspicious of products not made in America. Selling the concept of the multi-channel device and its benefits to US surgeons and deaf communities was also difficult due to American competition, in particular the 3M/House device promoted by the very eminent and respected Bill House. A critical problem for Cochlear was Clark's refusal to travel to the US, which constrained the team's promotional efforts. An even bigger challenge was to develop the protocol for the surgeons, audiologists and clinics in a pivotal study that would provide data for the ultimate FDA approval.

Mecklenburg publicised multi-channel cochlear implants and the Melbourne device at every available opportunity, including conferences, workshops and published papers. She and Brimacombe, her first audiologist, made a point of being the first to program a patient. They trained every clinician who had ever programmed a patient in the US, and slowly built up a team of reliable audiologists. In addition, the team was very strict about protocol to ensure that FDA approval was not held up due to unreliable data. The excellence with which the study was managed was highlighted by a panel member at the FDA hearing for the Nucleus System in 1985, who commented that he had never seen such high quality clinical data.

(ii) Long-term financial resources

Although the Australian Government had provided generous seed and early stage funding for developing the Cochlear product ($4.4 million by 1982), in 1983 the company was still several years from projected cash flow break-even, which was not expected until 1986. Trainor was unwilling to bear the burden of funding the entire 4-year period. Cochlear Pty Limited was established in part to facilitate external

fundraising in 1983. Trainor was determined that at least $3 million of the estimated further $5 million needed would have to be raised from external sources.

In the mid-1980s, the Australian financing community were part of a tightly regulated financial system, and were very conservative and inexperienced in sophisticated financial markets. They were particularly risk-averse with respect to technology-based investing. There were few venture capital investors, and few precedents for determining a company's value or the risks involved in Australian companies that planned to dominate global markets using novel technologies. The federal government's Management Investment Company (MIC) program was initiated to promote the development of a venture capital industry in Australia as a means of fostering young, Australian technology-based companies. Fortuitously, this initiative created a new pool of possible investment funds for Cochlear.

Finding suitable investors was complex. A net present value of projected cash flows was calculated and verified by Price Waterhouse as $20 million. Trainor understood that overseas venture capital industries were experienced in the biotechnology sector, and to establish a real value for the fledgling company he would need to go outside the Australian financial community that was unfamiliar with this type of company. He also determined that Cochlear would preferentially accept Australian financing. Furthermore, the availability of further government funding would need to be considered if the ownership of the company went offshore.

In the second half of 1983, Bear Sterns New York was retained to help the management team identify international venture capital investors. With a New York-based merchant bank to lend credibility, by December 1983 the team had secured an offer of A$3 million to buy 27.5% of the equity in Cochlear Corp, a US-based company that would own the rights to Cochlear Pty Ltd's technology. The offer set a value for Cochlear by an international player with expertise in high technology investment. Accepting this investment had several attractive features. The offer was on the table. The investor was US-based and could do much to support the establishment of US operations and the US regulatory process. If the planned exit from the investment was a NASDAQ listing, the support of US-based venture capital investors was essential. The price recognised a significant improvement on the funds attracted to date, a factor that would satisfy both Nucleus Ltd and the Australian Government. Surrendering significant ownership of the

company to a non-Australian party, however, would be less attractive to the government.

Concurrent with the international fundraising effort, Trainor also courted Australian investors. By mid 1984 three independent venture capital groups had expressed interest in investing small amounts in Cochlear Pty Ltd, although Trainor advised them he would prefer a syndicated investment. In late 1984 the Australian syndicate Western Pacific made an offer to buy 27.5% of Cochlear Pty Ltd for A$3 million.

Cochlear now had a choice of two offers. Accepting the Australian investment would have a number of attractive features. Cochlear Pty Ltd would remain Australian operated and owned and would have the support of local venture capital with a strongly commercial approach, important to management, staff and the Australian Government. Control of the company and the location of manufacturing and other operations would be linked to the nationality of the investor group. The Australian syndicate of investors also provided some capacity for future financing, if this became necessary. The Cochlear Board decided that a local investor would be easier to deal with from a logistical standpoint than one from overseas, and it accepted the Australian offer.

(iii) Manufacturing challenges

Cochlear was fortunate that Money had understood the complex nature of the Melbourne University prototype and that much of its redesign for commercial manufacture had been undertaken with assistance of government funding during the crossover phase. Manufacturing facilities were purchased adjacent to Nucleus headquarters in Lane Cove, a Sydney suburb, to allow knowledge transfer from sister companies. Close proximity to other Nucleus companies allowed economies of scale in administration and manufacture. In the US, Hirshorn hired part of Telectronics premises in Denver, Colorado, as Cochlear's US base.

Quality control was overseen by Mecklenburg and Patrick, often through on-site visits, a service offered by Nucleus at no cost to the patient. The Cochlear team adopted the strategy of going wherever they were needed, for any length of time and sparing no expense. They worked hard to be very professional, very confident and fast responders,

which made their chief competitor look sluggish and slow. It also gave the US specialists confidence in a device that was not made in the US.

(iv) Company structure and commercial expertise

Paul Trainor, Chairman of Nucleus, championed this stage of the company's progress. He had experience with the development, marketing and distribution of several devices, including the Telectronics pacemaker, and was the ideal person to lead this part of Cochlear's growth. Clark remained at MU continuing research into the development of an implant for children. David Money, who had spent many years working on the Telectronics technology, was appointed CEO of Cochlear. In December 1984, Ron West was recruited as the CEO of the US subsidiary, chosen by Hirshorn because he understood the medical professional culture as well as the technology and was not a person who focused just on sales. Money was also convinced that nationals would be the best people to lead overseas subsidiaries. West had worked for Johnson & Johnson and understood the US market, and eventually he took on the role as the first US CEO.

Once FDA approval was received in 1985, the company was able to sell its product in the marketplace and in the same year reached break-even point, which took it to the Resource Generation Phase of its growth. Additional subsidiaries were established in Europe, where regulatory regimes recognised FDA approval, and later in Japan. The company now focused on driving sales and generating additional resources and thus enabling the company to progress to its next phase.

Summary of Resource Mobilisation Phase

This phase of Cochlear's growth has been viewed through four elements, including business plan and strategies, long term financial and manufacturing issues and organisational structures. Table 5.6 summarises Cochlear's Mobilisation Phase, as discussed in this section.

Critical Problem	What kind of business model? How to manufacture a consistently high quality product? How to develop a strict protocol to satisfy FDA requirements? How to build up o/s teams of surgeons, audiologists & technicians that will comply with strict protocol? Where to locate US office? How to promote Australian product in US market with an American competitor? How to build up financial resources to sustain development to break-even point?
Critical Activity	Licence IP from Clark and MU team Production team with strong skills and personalities organised to undertake production in Australia Production located in Nucleus headquarters to allow for knowledge transfer from sister company Hirshorn and Mecklenburg sent to US to: 1. Source appropriate surgeons, audiologists, clinics & technicians 2. Develop appropriate protocol and supervise it 3. Develop selection procedures for 87 appropriate patients 4. Supervise clinical trials process 5. Set up subsidiary company and employ nationals to run it Trainor undertakes road-show to source sufficient funds from VCs Charge patients a price that will assist in keeping the company viable Focus on providing best service despite cost to prove credibility of foreign firm Build networks to assist with marketing in the US to show superior capability of Australian product
Solution	Successfully implant 87 patients across three continents within strict protocol procedures Achieve FDA approval Reach break-even point Employ US CEO Begin marketing implant in the US Move to Europe and Japan to establish additional subsidiaries Start generating resources Work on developing new product for children to extend product range

Table 5.6: Summary of Resource Mobilisation Phase – Cochlear

5.1.4 Resource Generation Phase

Problems throughout this phase revolved around assimilation of new members, building key relationships with customers and distributors and putting systems in place for effective production and market feedback.

In Europe Hirshorn repeated the process of finding an office, hiring a CEO and establishing a market. As in the US, he visited surgeons previously contacted by Cochlear, including Professor Ernst Lehnhardt in Hanover. From Lehnhardt's perspective, the Nucleus system provided a new treatment and he strongly promoted the project in Hanover. Lehnhardt travelled extensively training his colleagues in Germany, the UK, France, Austria and the Baltic countries, and within a year he had championed the largest implant centre in Europe using the Cochlear device. Furthermore, having written an audiology textbook in Germany he was highly respected in the ENT field in Europe. As the first customer in Europe he was a very important contact for the company.

Hirshorn initially set up an office in London, but eventually established a Head Office in Basel, Switzerland, for three reasons: to suit his replacement executive, to reach German, French and other markets, and to avoid an extremely high German tax regime. Hiring the European CEO, Dr Monika Lange (later Lehnhardt) to lead the new subsidiary was not easy. Lange had a prominent position in the pharmaceutical company Pharmacia, and the offer to work for a start up company from the other side of the world with only one customer was not very inviting. Although not trained medically, she had been working in a related field, and had qualifications in economics and marketing. Hirshorn persevered.

The job for this team was the same as it was initially in the US: train staff in various centres and hospitals throughout Europe in all aspects of rehabilitation and programming. Cultural problems within the multidisciplinary groups were eventually overcome. The most serious problem emerged was the lack of coordination between the production team in Australia and the sales that the subsidiary teams had made. Head Office in Sydney demanded increasing sales figures but the manufacturing part of the business could not produce the product fast enough to meet sales. Bottlenecks in production occurred partly because long lead times were necessary for changes to

production schedules and partly because the communication between the production team in Australian and the sales teams were not always clear. It was understandable therefore that with the need to meet financial targets, any shortage would cause significant tension within the team.

Eventually Hirshorn moved back to Australia and, after a year as CEO, took over the manufacturing section. Demand forecasting processes were streamlined in Australia and in the subsidiary markets new relationships with surgeons, clinics and patients were established. The superior quality of the product led to eventually taking over and absorbing much of the competition.

By 1990 Telectronics dominated the Nucleus Group with a turnover of approximately $350 million, compared with Cochlear's $10 million. Even so, it was running sufficiently short of cash to need assistance for further expansion. Trainor sold his shareholding to Pacific Dunlop on the undertaking that he would have no more to do with the business. In 1995 Pacific Dunlop sold Telectronics, and Cochlear was floated on the Australian stock exchange.

As a listed company, Cochlear moved out of its early growth phase with a new champion Catherine Livingstone leading the company through the new strategies and structures required for the next phase of growth, but this is outside the scope of this study. Table 5.7 summarises Cochlear's Resource Generation Phase, as discussed in this section.

Critical Problems	How to encourage initial entrepreneurial members to let go of autonomy – problems with assimilation Cultural perspectives create problems between US subsidiary and Australian Head Office Where to establish new subsidiaries to ensure growth of sales? Scaled up production creates bottlenecks as sales grow Lock in of some production routines Australian Head Office lacks understanding of overseas cut-throat competitive market - demands impossible budgetary outcomes leading to tension US markets want cosmetic changes – black/brown not just beige – Australian Head Office ignores request Aust Head Office lacks understanding of lobbying requirements for Health Insurance coverage – refuses funds
Critical Activity	European subsidiary established New CEOs and staff extend European network with ENT professors and surgeons Drives Sales Mecklenburg joins Basel team for transfer of knowledge Company CEOs establish effective practices to develop internal team work Build competencies by hiring local staff with marketing, distribution, coordination, administration and financial skills Put effective systems and feedback processes in place Hirshorn returns to Sydney to improve stability of production fluctuations Formal alliances developed with deaf communities, surgeons and audiology clinics Marketing strategies target end user customer Take over US competitor including its liability Research and develop new products for children to keep share of market
Solution	Build on past experience to reinforce continued growth in company capabilities Separate company from umbrella group and list on stock exchange as separate entity New Head Office CEO with strong financial and business skills Extend product to children's market and hearing impaired not just profoundly deaf market Build on promotion to deaf communities Continue to improve technology

Table 5.7: Summary of Resource Generation Phase – Cochlear

5.2 Novogen Limited

Novogen Limited was founded in Australia and is now an international biotechnology company involved in drug discovery and product development for disorders that are commonly associated with aging. Currently the company is based in Australia and the US. Its technology platform is based on converting isoflavonoid compounds into products to treat and prevent major human degenerative diseases.

The case study is compiled from a substantial body of publicly available material (Knapp, 2000; Naughton, 2000; Springer, 2000; AIHW, 2002; Gozlan, 2002b; Branca, 2003; Zavioco, 2005) and five personal interviews. Interviews were conducted with Professor Graham Kelly, scientist and original CEO; Christopher Naughton, current CEO; Alan Husband, Research Director; Peter Bradfield, an original director, now retired; and Professor Leanna Read, current board member. Additional sources of information included company website and the 1987–2005 company annual reports. A detailed description of the Novogen Ltd case study is presented in Appendix 2.

5.2.1 Resource Access Phase

This section of the case study revolves around the discovery component of the value chain, comprising idea generation, idea evaluation, feasibility of concepts and proof of principle. It focuses on the numerous problems of matching the opportunity of developing a drug that could kill cancer with the resources to realise the opportunity. As in the previous case study, this firm's growth through the Resource Access Phase is viewed through four elements: the entrepreneur, the technology, the financial and the environmental constraints faced by the company.

(i) Entrepreneur

Professor Graham Kelly completed his PhD on the manufacture and use of an experimental drug to overcome tissue rejection in 1972. As a Senior Research Fellow within the Department of Surgery at Sydney University and Director of the

Transplantation Laboratories, his research over the next 20 years focused on the increased risk of cancer development in transplant recipients.

Trained as a veterinarian, Kelly was aware of 1950s research that demonstrated sheep eating clover, a source of phytoestrogens, had fertility problems. He was also aware that blood contains two types of oestrogen – steroidal oestrogens made in the body, and non-steroidal oestrogens or isoflavone phytoestrogens, obtained from food. Kelly's research into isoflavones was sparked after a report by British scientists in the early 1980s that found phytoestrogens in the urine of vegetarian women. He wondered if changes in women's diets could assist in combating degenerative disorders such as cervical and breast cancer.

He began to research traditional diets and observed the absence of menopausal discomfort in women, and low rates of heart disease in both sexes, in Asian and Central American communities. All these cultures consume diets rich in legumes such as chick peas, lentils and soy beans. His studies revealed that women in these cultures did not suffer western menopause symptoms such as mood swings, sweatiness and vaginal discomfort. They did not even have words for symptoms such as hot flushes. It appeared that although plant oestrogens have always been in the diet, as Western diets substitute greater amounts of meat for legumes, they reduce the protection of isoflavones. Kelly noted that Japanese women who move to western countries face higher risks of age-related diseases due to the resultant change in diet. He also observed that the incidence of various cancers was considerably lower in those countries and thought that this may explain the epidemiologic variance of many hormone-dependent diseases. He proposed that diets rich in phytoestrogens may help prevent typical Western diseases, especially certain types of cancer. By the mid-1980s, having become increasingly disenchanted with the general direction being taken by medical research in finding an answer to what he saw as the cancer epidemic facing Western communities, he began to seek alternative approaches to provide answers not forthcoming through conventional approaches of that time.

Kelly confesses that his philosophy was influenced by the professor of surgery with whom he trained. In Kelly's eyes his mentor, Professor Shiel, took big leaps into the unknown and was always prepared to look for other solutions if a strategy didn't work out. Kelly developed a disregard for the faint-hearted and he considers that this

characteristic is perhaps fundamental in assisting him with the founding of a company whose whole science is based on something that was considered to be totally unconventional.

Although he was an academic, he always had a commercial perspective and was always keen to be involved in some sort of commercial activity. Early in his career he operated a small veterinary practice from home in the evenings and weekends keeping him in touch with the commercial world outside academia. His immediate social network included Mal Logan, a retired accountant and businessman, and in the 1985 he and Logan began to develop creams and potions for veterinary use, establishing a company called Norvet Laboratories Pty Limited to manufacture and distribute these veterinary products while Kelly continued his research into the impact of isoflavones on degenerative diseases at the university. With another entrepreneurial contact, John Clark, Kelly formed a partnership to supply specialty feed for laboratory animals in 1987; this was eventually licensed by a large distributor, Goodman Fielder. These experiences established his commercial contacts, building commercial capabilities and extending his entrepreneurial drive.

Critical Problem	How to use 20 years of research experience to build on a scientific idea? How to convince conservative scientific colleagues the benefits of plant hormones known as isoflavones is not just an 'alternative' medical fad? Research and substantiate the importance of isoflavones in providing a wide range of estrogenic benefits to both men and women?
Critical Activity	Using positions as Senior Research Fellow within the Department of Surgery and Director of the Transplantation Laboratories at Sydney University to gain access to essential equipment & lab facilities for research Lead students to identify the best sources of isoflavones and to develop techniques for extracting isoflavones from red clover and then prove their medicinal benefits Develop commercial contacts
Solution	Develop competence to promote the concept and the benefits of the idea, and prove its feasibility Use untraded resources such as laboratory facilities, equipment and students to complete project

Table 5.8: Resource Access Phase entrepreneurial challenges – Novogen

Kelly was unsuccessful in raising interest at Sydney University in legal and financial support for his project. Nevertheless, he continued with the research, using university facilities and students, and for four years he and his team undertook the required research to prove the concept, working under the very difficult resource conditions at the university. Once he gained the interest of a commercial partner and was able to demonstrate the commercial feasibility of the concept, he left the university and went to a public listing, thus progressing his idea from the Access Phase to the Mobilisation Phase of growth. Table 5.8 summarises the entrepreneurial market aspirations of Novogen's scientific entrepreneur, as discussed above.

(ii) Technology

Throughout the 1950s and 1960s, veterinarians were becoming interested in plant hormones known as isoflavones. Research began to demonstrate that these compounds contributed beneficial oestrogenic effects in animals. Kelly's research extended these findings and demonstrated that the compounds were also a natural part of the human diet with important dietary components that could provide a wide range of oestrogenic benefits in both men and women. Before any commercial benefits could be achieved, the research needed to provide evidence that diets rich in phytoestrogens could actually influence hormone-dependent states, such as in premenopausal women. However, not all isoflavones have similar impacts on the body. For instance, soy extract is known to lower total cholesterol levels while other isoflavones are able to raise HDL or "good" cholesterol.

Extensive testing eventually identified a particular type of red clover that produced the most effective isoflavones for his research. Kelly was able to demonstrate that red clover was the only plant to contain four potent oestrogenic isoflavones that produce the desired results. The compounds had to be extracted from the plant, but identifying the most appropriate methodology was time-consuming and costly.

Kelly's contacts in hospitals and university research teams proved very useful during this period, providing him with the facilities, researchers, equipment and ideas to reach proof of concept for the alternative medical market. The unique IP attracted the interest of a commercial partner and the commercial arrangement demonstrated the feasibility or

market potential of his idea. Table 5.9 summarises the technological development through the Access Phase.

Critical Problem	How to prove the dietary influence of isoflavones on hormone dependent states? What plants would be best providers of isoflavones? How to extract the compounds out of the plants in sufficient quantities for the research? Do isoflavones have the capacity to kill cancer cells? How to convince the Medical profession and funding bodies to see this as real medicine?
Critical Activity	Lead students and colleagues to: 1 identify best source of isoflavones 2. identify best techniques for extracting isoflavones from red clover through research 3. prove their medicinal benefits 4. Promote research findings and build networks for technical support
Solution	Demonstrate the possibility of the concept Prove the feasibility of the idea Patent the IP

Table 5.9: Resource Access Phase technological challenges – Novogen

(iii) Financial resources

Kelly's appetite for taking risks and his commercial perspective convinced him that by 1993 that there was an enormous commercial opportunity for the isoflavone research. But the academic world was not interested; the university saw no need to contribute to taking out a patent on his research and although he applied several times to the National Health Medical Research Council (NHMRC) for funding, he was unsuccessful in obtaining financial support.

Financial resources were always a problem for the project. However, the commercial ventures Kelly had established provided him not only with commercial skills outside the university but also funding for the project during critical periods. For instance, his

veterinary company, Norvet, provided the legal and financial assistance to take out a patent. Without such assistance it would have been much more difficult for the scientist to progress the development of the concept. But Norvet was a veterinary company and the isoflavone research focused on human treatments, giving him an incentive to look for additional financial sources. Table 5.10 summarises Novogen's financial challenges in the Access Phase.

Critical Problems	How to fund the research in terms of facilities, equipment, and salaries? How to pay the patenting costs? How to fund the manufacturing costs?
Critical Activity	Seek funding from NHMRC Seek financial and legal assistance from university Use partners for critical financial shortages
Solution	Patent the IP through Veterinary company Use university and hospital facilities and equipment to maintain research program

Table 5.10: Resource Access Phase financial challenges – Novogen

(iv) Environment

During the early stages of his research, Kelly was a lonely voice in the cancer research environment. Chemical research was recognised as the process for finding solutions to medical problems. Biological research, especially that conducted by a veterinary surgeon, did not receive approval or recognition from the scientific community and Kelly was not taken seriously by medical funders and researchers.

By the 1980s perceptions began to change. Negative side effects of oestrogen drugs for Hormone Replacement Therapies (HRT) were becoming better known and women began seeking alternative therapies to relieve menopausal symptoms. The benefits of soy products began to be accepted as a suitable alternative and Blackmores, an alternative therapeutics distributor, was keen to partner with a research team that could add to their alternative medical collection of products. It was in this environment that

Kelly was able to clearly demonstrate a market potential for his concept. Table 5.11 summarises these environmental issues in Novogen's Access Phase.

Critical Problem	How to increase very low levels of interest in the research area? Negative perceptions of isoflavones – how to demonstrate their positive benefits to increase interest? How to utilise societal changing attitudes for most benefit to the project?
Critical Activity	Use changing market perceptions to promote the products Develop commercial contacts to raise funds for research Make use of Vet company partners to assist with structuring partnership with multinational herbal therapy distributor
Solution	Commercial partner funds manufacture, marketing and distribution of new products

Table 5.11: Resource Access Phase environmental challenges – Novogen

Summary of Novogen Limited Resources Access Phase

The Resource Access Phase of Novogen's growth path has been viewed through four elements: the entrepreneur, the technology, financial resources and the environment. The elements are interdependent and their interaction has contributed to a successful outcome for this phase, where sufficient resources were accessed to progress the project to the next Mobilisation Phase.

However, as with to the Cochlear case study, although the Access Phase had been completed, a crossover phase was necessary before mobilisation of resources could commence.

5.2.2 Resource Access/Mobilisation Crossover Phase

Kelly's joint venture with Blackmores agreed to develop over the counter (OTC) products for the alternative medical market. Although still under the scrutiny of a regulator, the alternative products did not require the same level of testing that a drug

would attract and would consequently cost less. An additional attraction for Kelly was that he could manufacture the isoflavones at the university and Blackmores could provide the expertise and networks to market and distribute the product, while research continued for drug development.

A commercial agreement with a multinational herbal distributor was beneficial to the project on a number of levels. The partner was a major source of financial resources to assist with continuing R&D costs. It also gave the concept commercial viability, therefore attracting additional interest from the market and the academic environment. The partnership did not survive long. Kelly considers that Blackmores demanded very tight margins and timelines that the scientific team believed to be unrealistic. Blackmores also began to focus their attention on soy products, which by now had gained credence in Western societies. Blackmores offered to buy him out but Kelly refused the offer and eventually an end to the joint venture was negotiated. Although the university continued to provide free laboratory facilities, by the mid 1990s R&D costs were rising and at this point Kelly decided to leave the university. He and his veterinary business partners agreed to join forces and go to a public listing. Table 5.12 summarises Novogen's Resource Access/Mobilisation Phase.

Critical Problem	How to meet deadlines lines and manufacturing amounts set by commercial agreement? How to maintain ownership of research direction? How to pay for escalating R&D costs for drug research?
Critical Activity	Maintain focus of research Keep ownership of IP Search for alternative methods of financial arrangement to pay for R&D costs
Solution	Dissolve partnership Leave university Go to IPO

Table 5.12: Summary of Resource Access/Mobilisation Crossover Phase – Novogen

5.2.3 Resource Mobilisation Phase

This phase of the case study revolves around the conversion of assets that have been assembled in Phase I to generate resources. It focuses on the development of isoflavone products to successfully gain regulatory approval through various trials so as to progress the company to production scale up and marketing. The four elements that make up this phase include the development of business plans to employ commercial expertise, solving long term financial and manufacturing issues and building appropriate organisational structures so as to enable the company to reach break-even point and begin to make profits.

(i) Developing a business plan

During the Access Phase of his project, Kelly had overcome difficulties to access critical resources for the development of his technology. By 1994 the intellectual property he created was demonstrably unique. He had established a social network of associates that provided a broad range of expertise in business, marketing, accounting, product development, medicine, biology and veterinary science. It was very fortunate timing to go to a public listing in 1994. The state of the stock market meant Kelly had no trouble obtaining $A6.5 million in financial resources. Physical resources at Northbridge, a Sydney suburb, were leased and additional laboratory/manufacturing facilities were leased from the University of Sydney to take the company through its initial growth stages. Norvet Limited, Kelly's small veterinary business, became a registered company in March 1994 and Norvet shares and options were listed on the Australian Stock Exchange on 1 September 1994.

Reflecting similar practices in early biotech companies, Norvet's initial business plan embarked on a wide-ranging R&D program to exploit four areas of research:

- β-1,3-glucan for healing ulcers
- a tick paralysis vaccine
- an agreement with Venom Supplies and Medvet Science Pty Ltd for the cooperative development of the next generation of anti-snake venom

- development of drugs based on research on isoflavones for reproductive hormone functions.

Bradfield, one of Norvet's original directors, had invested in the company for its tick vaccine. He knew the tick was killing cattle on the eastern seaboard and contributing to its eradication would have Australia-wide benefits. Unfortunately, the gene was eventually discovered but the potential returns made its manufacture unsustainable. The snake vaccine research also indicated no financial future.

The company's glucan research appeared for a time to be headed in the same direction as the snake venom and the tick vaccine. Initially research into glucans was prompted in the early 1990s by interest in immunostimulants – drugs that could safely and effectively promote wound healing despite the increasing emergence of antibiotic-resistant bacteria. Studies by Norvet had been able to concur with overseas research that β-1,3-glucan was a potent and safe immunostimulant in both animals and humans, but the company could not demonstrate how it worked and research was stalled for several years. It was not until 2003 that reliable results were achieved and Glycotex Inc., a US subsidiary, was specifically established to develop glucan technology. Lacking returns from its tick and snake venom research, and with growing worldwide scientific interest in phytoestrogen research expanding rapidly, Norvet redirected its resources towards the development of its isoflavone technology platform and the production of OTC products in 1997.

(ii) Long-term financial resources

Norvet's flotation provided Kelly with A$6.5 million, far greater than he had imagined possible while working at the university. However, by 1998 it became evident that further working capital was required to meet the cost of establishing a manufacturing facility in Wyong, on the outskirts of Sydney. The directors authorised a placement of 2,690,000 fully paid ordinary 25-cent shares and 1,299,000 options exercisable to 31 December, 1998 at 50 cents. The placement raised $3.27 million. This was similar to earlier actions in 1996 when the shareholders had agreed at an EGM to issue an additional 6 million shares at $2.50, in order to accelerate the company's isoflavone technology which had progressed to a commercial stage substantially faster than

originally anticipated. This placement raised $A15 million. Further private placements raised $A24.4 million in 1999, $A17.9 million in 2000 and $A21 million in 2001.

Norvet changed its name to Novogen and in 1997 it entered a licence agreement with Dupont Protein Technologies and its subsequent joint venture with Bunge, now called Solae LLC, to make regular milestone payments and to pay royalties on sales of its products covered by the Novogen patents. DuPont Protein Technologies obtained the worldwide rights (other than for Australia and New Zealand) to certain Novogen soy isoflavone technology. In the deal, Novogen retained all rights to its own red clover-based isoflavone technologies and the licence related specifically to Novogen patents or patent claims relating to soy applications. Novogen received initial consideration of $A15.7 million, and an additional payment by way of equity placement of $A3.6 million in November 1998. Later, in 2002, Novogen received the first milestone royalty payment under the licence of $A1.6 million and, in January 2003, a further $A2.3 million milestone royalty payment was paid.

As the importance of this research for national health became recognised, Novogen had been awarded a $A3.74 million START grant in 1999. In 2000 the company was able to obtain further funding from the START fund for $A2.79 million to assist in the development of phenoxodiol. By 2001 the company's profile was such that the Prime Minister said that he was pleased to announce that the R&D START grant had offered Novogen a further $A3.7 million to develop its promising experimental anti-inflammatory drug, NV-07. A total of $A10.23 million had been obtained from government programs between 1999 and 2001. Husband, the head of research, reflected that although investor confidence can make or break a company, government grants are certainly very helpful in assisting the company to do things more rapidly and spread its focus a little wider than perhaps is otherwise possible.

Sale of OTC products also provided substantial financial resources for the company but the cost of marketing these products in the US and Europe was high. Clinical trials and R&D also continue to place substantial constraints on the company and break-even point is still to be achieved.

(iii) Manufacturing issues

In 1995 an important technical development led to the company's first generation iso-phytoestrogen product Pratensil (later changed to Promensil), which was expected to provide the basis for various OTC products. This was a herbal product, rather than a pure drug, derived from an approved human foodstuff, red clover, so Pratensil could be registered for sale in most countries without undue delay. Convincing trial results opened up the way for Promensil to be presented to the market as a safe and alternative therapy for those women who chose not to use the traditional HRT in 1997. Building on this technology, the company released Trinovin for maintaining prostate health in men in 1998 and Rimostil, for maintaining post-menopausal women's health in 1999.

In November 1996, the company opened its large-scale manufacturing facility in Wyong, New South Wales to extract iso-phytoestrogens from plant material. Novogen's extraction technology ensured a highly efficient and cost-effective extraction of isoflavones in a non-destructive manner. The scale of the state-of-the-art facility in Wyong was designed to have sufficient output capacity to produce approximately 600 million tablets per annum, the quantity anticipated the demand for the world-wide commercialisation of Promensil. The facility also began to manufacture a range of isoflavone products for future clinical trials of its therapeutic drugs.

The Wyong facility was accompanied by the expansion of the company's clover production with increased scale of production producing significant improvements in efficiency. The expansion of raw material production and handling capacity continued to be progressively updated to meet forecast market demand. In 1997, Novogen appointed Sigma as the licensed contractor to tablet and package sufficient product to meet projected worldwide demand for finished goods. The tableting and packaging of products for world distribution has now been extended and is performed under contract in Australia and the US.

The OTC products provided the company with some major opportunities. Receiving regulatory approval in 1997, the company was able to launch Promensil in Australia that year and the in the US in 1998. Sales of the product generated much-needed cash and the company now had the opportunity to simultaneously establish its commercial brand in the global market and gain international experience with which to promote

future products. In line with its new direction the company name was changed from Norvet Pty Limited to Novogen Limited to reflect its change from a veterinary to a now largely human focus. A few years later the company was able to establish additional associations and networks during the promotion of its OTC products.

(iv) Building appropriate corporate structures

In August 1996 Chris Naughton joined Novogen as a commercial director. With degrees in Economics and Law, he had completed the program for Management Development at the Harvard Business School, and had been an Attorney in New South Wales. He had worked as a merchant banker, and spent 11 years in the pharmaceutical industry, including worldwide business development with the Wellcome Foundation Limited in the UK. Novogen's business was growing very quickly once the OTC products were being marketed, and the company needed someone with strong financial capabilities. Kelly realised the company would benefit with Naughton as CEO and stepped down from the position within a few months; Naughton is still the CEO and is described as the driving commercial force of the company. Kelly and other directors consider that without Naughton's international commercial and legal skills, the company could have folded.

In 2000, Novogen chemists changed the shape of the naturally occurring plant isoflavones and produced new compounds that were many times more potent than the original plant compounds, but retained their selectivity for cancer cells. Phenoxodiol (NV-06) was one of those compounds. Although a very exciting discovery, this new compound created a new challenge. The question of how to fund the program became paramount. The testing program had moved from Phase I trials, and was on the cusp of moving to Phase II, which was much more expensive. Because it was a new idea, it was like a new company. It was a part of Novogen but there was no benefit in financing it through Novogen, which was a combination of ideas and projects. Novogen's OTC business was generating revenue and gave analysts a basis on which to measure the business, but this meant that the research and development of the new idea would be ignored. The company felt that by having a consumer business they effectively relegated the intellectual property value of the new idea to zero. They considered it to be essential to take the new intellectual property out of Novogen and deal with it

separately in a subsidiary company and thereby establish a value for it which had nothing to do with the OTC business. In preparing the commercialisation strategy for phenoxodiol, the company established a new subsidiary Marshall Edwards Inc (MEI). Competition between the Melbourne and Sydney ASX offices created listing problems for MEI, and Novogen experience a frustrating year as the ASX continued to put obstacles in the way of publicly listing MEI. To expedite the phenoxodiol clinical program, Novogen raised $US10 million in May 2002 by floating MEI on the London Stock Exchange's Alternate Investment Market (AIM). The directors of the company are adamant they will not attempt a public listing in the Australian market again.

There are now two branches of Novogen activity. The first branch manufactures products that can be sold over the counter without a prescription. The second branch, and the main thrust of the company's R&D, continues to be the development of drugs that treat degenerative diseases. Glycotex Inc. was listed on the NASDAQ in 2003 as the commercial vehicle for Novogen's glucan (skin care) technology. The Pharmaceutical Research and Development owns the group's intellectual property and manages the laboratory and preclinical activity across each therapeutic area that has compounds under development. The company has assembled an extensive IP portfolio and product pipeline based on its phenolic compound technology. It is using this portfolio to establish a vertically integrated pharmaceutical business embracing drug discovery, R&D, manufacturing and marketing of OTC products.

Several of the original board members left the company shortly after the listing of MEI, through a combination of the need to provide solid scientific and financial advice and the difficulty in reaching agreement about the new growth strategies. However, they left the company having made substantial contributions to its success in the early difficult days.

Apart from its internal structure, the company is aware of the necessity for biotechnology start-up companies to become embedded in both local and global industry networks, depending on the stage of development. These networks include research institutions, hospitals, and partners and alliances with the capacity to provide the infrastructure to take the product through to the final stages of commercialisation. Such associations can allow R&D projects to be accelerated, reduce the cost of the research,

enhance both the likelihood and the rate of entry of products into the marketplace, and provide an important additional knowledge asset with which to extend growth plans.

In 2005 Novogen's major revenue generator remained the OTC business. Despite the impressive success of these products, the company has not yet achieved break-even point and still faces an operating loss of $10.5 million. Challenges in achieving the full benefit of its resources include the Phase III trials of its phenoxodiol drug and the ability to find an appropriate cosmetics partner for the commercialisation of its drug NV-07α. Other hurdles depend on the success of a number of drug trials, which will inevitably impact on Novogen's ability to reach resource generation or the next phase of its growth.

Summary of Resource Mobilisation Phase

This phase of Novogen's growth has been viewed through four elements: the business plan, long term financial and manufacturing issues and organisational structures. The company has still not reached break-even point despite earning significant revenue. It remains within the Resources Mobilisation Phase. Table 5.13 summarises Novogen's Resource Mobilisation Phase.

Critical Problem	What kind of business model? Who best to lead the company? How to maintain a steady source of finance? How/where to grow the best clover? How to develop the best methods for compound extraction? How to market the OTC products? How to structure the company for new compounds? How to overcome obstacles to floating subsidiary company? How to build appropriate networks?
Critical Activity	Float veterinary company and develop compounds Use stock market for additional funding Licence non essential IP Seek government grants Purchase manufacturing premises Use contract growers to ensure constant supply of clover Continue research for clinical drug Manufacture and market OTC products on global market for experience and brand exposure Restructure company for new compounds Go to global listing when local market not empathetic
Solution	Change leader Restructure business plan Restructure company Streamline marketing expertise for OTC products Build networks to assist with clinical trials for new drugs Maintain R&D program

Table 5.13: Summary of Resource Mobilisation Phase – Novogen

5.3 BTF

BTF is a biotechnology company based in Sydney, Australia, supplying customers worldwide with precision solutions for microbiological testing. The company's initial products set the standard for precise *Giardia* and *Cryptosporidium* (C&G) quality control and this precision has been extended with its BioBall product to a wide range of bacteria including *E. coli*, *Salmonella Bacillus* and *Listeria.*

Information regarding this company was very difficult to obtain. At the commencement of data collection, BTF was a new company. The two directors had recently secured some venture capital after a prolonged period and were very concerned that any commercially sensitive information would damage their position. Therefore, only publicly available information from analysts, the company web site and newspaper articles, and three interviews make up the data for this case study. Initial interviews were conducted with Graham Vesey and his partner Mark Gauci. Mark Gauci was happy to provide additional information two years later but was not able to provide copies of any original documents. A detailed description of the BTF case study is presented in Appendix 3.

5.3.1 Resource Access Phase

This section of the BTF case study, as specified in the methodology, revolves around the discovery component of the value chain where activities comprise idea generation, idea evaluation, feasibility of concepts and proof of principle. It focuses on the numerous problems of matching the opportunity of establishing a diagnostics company focusing on developing technology for microbiological testing. As in the previous case studies, the Resource Access Phase is viewed through four elements as prescribed in the Garnsey (1998) model: the entrepreneurs, the technology, the environment and the financial constraints faced by the company. By finding solutions to the problems throughout this phase, the entrepreneurial scientists, Graham Vesey and Mark Gauci, have been able to take Vesey's initial idea to proof of concept and commercial feasibility, and progress the project into the Mobilisation Phase of growth.

(i) Entrepreneurs

Dr Graham Vesey, microbiologist

Vesey came to Australia from the UK where he had worked in some of the biggest microbiological labs in the country and had a very strong history in dealing with public health. He worked with Colin Fricker at Thames Water in the UK on detecting and monitoring *Cryptosporidium* levels in drinking water. *Cryptosporidium* is particularly a threat in developed countries, and as it is not affected by chlorination its removal requires a water filtration system that must be monitored. Disease was first linked to this organism in water in the 1980s, when significant outbreaks were being identified in the community and water companies were required to deal with them. There were no efficient methods of monitoring bacteria in drinking water so Vesey and Fricker developed some of the early methodology of checking for *Cryptosporidium*. Fricker eventually became a mentor for the two founders and now sits on the BTF board.

Sydney Water recognised Vesey's skills and offered him a scholarship to enrol in a PhD program at Macquarie University. In the second year of his PhD, Vesey was using an instrument that was originally designed for blood analysis to look at C&G pathogens. Attempting to adapt the cytometer for the water problem was technically challenging. He needed to work with someone who could understand exactly how the instrumentation worked and then potentially optimise it. At this stage he employed Mark Gauci.

Mark Gauci, laser technologist

Gauci had just graduated in opto-electronics at Macquarie University, specialising in lasers, optical fibres and electronics, when he joined Vesey. They worked together from 1993 to 1998 and developed a monitoring methodology for Sydney Water. The team's highly sensitive technology was implemented for the first time during the Sydney water crises in 1998. It proved to be more sensitive than any previous tests and, although the work came under a huge amount of scrutiny, it proved to be very successful.

Mentors at the university, such as Professor Keith Williams, encouraged the partners to think about commercialising their unique technology. Others encouraged them to use

their success and their association with Sydney Water to form a company. However, neither of the partners had commercial or business experience, they had a sparse publication record, and they were unsure of their earning potential. Table 5.14 summarises the entrepreneurial market aspirations of BTF scientific entrepreneurs, discussed above.

Critical Problem	How to use ten years of research experience to develop reliable methodology for monitoring C&G in drinking water? Where to find expertise in opto-electronics? How to best provide service to a potential customer?
Critical Activity	Combine forces with laser technologist colleague at the university Adapt available instrumentation for optimum use Develop monitoring methodology for Sydney Water
Solution	New technology used during Sydney's water crises Proven to be more sensitive than any other available tests anywhere in the world

Table 5.14: Resource Access Phase entrepreneurial challenges – BTF

(ii) Technology

One of the difficulties of microbiological testing is that quality control procedures are time consuming, costly and reasonably inaccurate, with thousands of tests needed to accumulate valid statistics. The partners use globally recognised Mongolian gerbils, bred in the US, to obtain the C&G strains. The bugs are dispensed in accurate numbers using BTF platform technology then irradiated at Lucas Heights in Sydney. The radiation breaks the *Cryptosporidium* DNA so it cannot reproduce and can be safely shipped. Although the costs are high the increased value to the raw product is significant and margins are also high. The expertise to carry out the process is unique and BTF own the intellectual property. Table 5.15 summarises the technology challenges faced by BTF in its Access Phase.

Critical Problem	How to research C&G pathogens to determine their behaviour? How to modify current instrumentation to undertake testing efficient testing procedures? How to develop quick and efficient methodology for testing C&G bugs in water?
Critical Activity	Develop expertise in instrumentation Develop new method of testing for C&D bugs in water
Solution	Prove the concept by providing Sydney Water with very sensitive tests developed within Macquarie University to speedily and accurately test for C&G in water

Table 5.15: Resource Access Phase technological challenges – BTF

(iii) Financial resources

The development of the technology was undertaken while the partners were employed within and paid by the university, and their association with Sydney Water provided funding for the development of the technology. For instance, Gauci used Sydney Water funding to modify a cytometer that belonged to the university.

The intellectual property was also patented by the university. Although this was initially a benefit in that the partners were not burdened by legal, administrative and financial problems, when they wanted to leave the university they had to negotiate with the university to use the intellectual property. Table 5.16 summarises BTF's financial challenges in its Access Phase.

Critical Problem	How to finance equipment and facilities to develop the instruments for water testing? How to patent the new technology?
Critical Activity	Use university for access to funding for equipment, materials and patent services
Solution	Develop unique technology platform using university and Sydney Water for financial support

Table 5.16: Resource Access Phase financial challenges – BTF

(iv) Environment

In many major cities around the world, pastoral land comes right up to water catchment areas. Cattle deposit faeces containing organisms like C&G near the water. Once in the system, the bacteria can last for years in the environment, then be washed into the dam and become infective. In the last 30 years, chlorination of water supplies in developed countries has added substantial improvements to the quality of urban water. However, C&G organisms are extremely hardy and survive almost anything including disinfection. Only UV radiation and boiling will destroy them.

Testing for pathogens can be complicated and costly, and therefore the water industry has been reluctant to implement stringent tests for the organisms. However, as media coverage of outbreaks raised public awareness and fear of possible infection intensified, social and political pressure was applied to public utilities to urgently improve the monitoring processes. In response to similar concerns from governments and environmental planning and protection authorities around the world, the international water industry began to upgrade its monitoring efforts, implementing constantly monitored water filtration systems to ensure adequate quality measurements. In the Sydney 1998 crisis, once the purifying plant was cleared, the crisis subsided; however, averting future crises depended on Sydney Water's ability to maintain an efficient monitoring system of its water supply. This policy provided the partners with a long-term customer. Gauci understood that although the idea was simple, its time had come. Table 5.17 summarises the environmental challenges for BTF in its Access Phase, described above.

Critical Problem	How to use societal changing attitudes for most benefit to the project? How to best supply customer with best service?
Critical Activity	Demonstrate efficiency of technology in competitive environment of Sydney water crises Maintain commercial relations with Sydney Water
Solution	Manufacture technology within university environment for Sydney Water

Table 5.17: Resource Access Phase environmental challenges – BTF

Summary of BTF Resources Access Phase

The Resource Access Phase of BTF's growth path has been viewed through four elements as specified in the methodology and Garnsey's (1998) model: the entrepreneur, the technology, financial resources and the environment. The elements are interdependent and their interaction has contributed to a successful outcome for this phase of the project's growth. Financial and technological resources have been accessed by the partners to begin the Mobilisation Phase and begin to commercialise the product. However, in this case, the Mobilisation Phase as described in the methodology is complicated in that the partners have not taken the opportunity to move to a commercial environment, but have taken the less risky path by continuing to work under contract to the university whilst still working for the university. This intermediate part of their growth has been included under a Resource Access/Mobilisation Crossover Phase.

5.3.2 Resource Access/Mobilisation Crossover Phase

This phase of the BTF growth path does not fit the specified methodology. The partners have accessed resources and taken their technology to proof of concept. To add value they have entered an agreement with a customer, Sydney Water, to begin mobilising their testing technology for financial rewards. However, they have not left the university environment. That is, they are still employed by the university while also working part-time as contractors to the university, having licensed their IP from that institution. Gauci thought the least risk strategy was to stay part-time at the university until they built up experience in the business. It took only a few months of the team working after hours manufacturing their products for Sydney Water before it became evident that they should go out on their own.

Vesey and Gauci were increasingly frustrated with the university's rate of commercialising its research technologies. To start their own business would be difficult without access to the papers they had written over the previous 3–4 years and they could not take their commercial results. Gauci felt particularly at risk. He had graduated but had not been part of the telecommunications boom for which he was trained, and he did not wish to remain at the university to pursue a research path towards a PhD and academia. In 1999 they agreed to start their own business.

The partners were encouraged in this move by Keith Williams who had been a professor at Macquarie University and a mentor to the young partners. Williams had left the university and was in the process of forming his own company Proteomic Systems Limited (PSL). He offered spare space in a PSL laboratory and access to commercial expert contacts that the partners accepted. Table 5.18 summarises BTF Access/Mobilisation Crossover Phase challenges as discussed above.

Critical Problem	How to commercialise the technologies out of their research without owning IP? How to gain business expertise without risking income stream? How to remedy frustration with university's lack of commercial focus?
Critical Activity	Maintain business relationship with customer for revenue stream Manufacture water products at the university under contract despite increasing frustration of not realising the full potential of the commercial possibilities
Solution	Move out of university and establish a business for an established customer

Table 5.18: Summary of Resource Access/Mobilisation Crossover Phase– BTF

5.3.3 Resource Mobilisation Phase

This phase of the case study revolves around the conversion of assets that have been assembled in Phase I to generate resources as specified in the methodology. As per the Garnsey (1998) model, this phase of the company's growth focuses on the development of proven unique technology and commercialisation of the resulting products in order to progress the company to break-even point where the Resource Generation Phase begins. The four elements that make up this phase as specified in the methodology include the development of business plans to employ commercial expertise; solve long term financial and manufacturing issues and build appropriate organisational structures so as to enable the company to reach break-even point and begin to make profits.

(i) Developing a business plan

In the Access Phase, problems facing Vesey and Gauci had been technical, including the understanding of the pathogens and the development of the instrumentation. Until that time the university had provided the facilities, access to research funding and research assistance, enabling the colleagues to produced unique technology, a commercially viable product and access to a customer, Sydney Water. Going into business required a business plan. They turned for advice to their networks.

The first BTF business plan was written with assistance from past colleagues and the partners approached the federal government for a START grant. However, a condition of the grant was that they would provide an equivalent amount of finance. As their resources were limited, he partners looked to their mentor Williams and his network of commercial experts within Xcelerator, the first biotechnology incubator in Sydney. The incubator's objective was to provide start-up companies with mentoring access to contacts in the commercial world as well as facilities. The arrangement between BTF and Xcelerator was formalised and the incubator took 10% ownership of the company, with Vesey and Gauci receiving crucial commercial expertise and help at a very critical stage of the business. They could present problems and possible solutions to Xcelerator members and have commercial expert input. Furthermore, the additional Xcelerator partners' networks were able to extend BTF's network of specialist assistance and underwrite the first business plan.

(ii) Long-term financial resources

The company was fortunate from a financial perspective in two ways. Its mentoring group had succeeded in gaining $202,000 and they already had a customer that provided cash on a steady basis. However, dependence on short term cash-generating activities meant that there was always an urgency to sell the early products and the partners focused their activities on building relationships with people like BD, an instrument distributor, and other similar groups to develop their reference material. Fortunately Vesey and Gauci had their own contacts in the C&G market in Australia, the US and the UK. These contacts, and the production of a 1-page flyer, facilitated global sales that

provided the company with business for a couple of years. However, they were keen to pursue additional opportunities for growth.

Colin Fricker, who had worked with Vesey at Thames Water, recommended BTF products when investigating worldwide C&G problems. He also provided excellent advice on the company's long term strategies, suggesting that more profitable opportunities were to be found working on bacteria. However, they would need additional finance to undertake such a strategy and Rory McCloud, one of the PSL team and a merchant banker with Macquarie Bank, was asked for his assistance to search for product development funds in 2001.

The frustrating search continued for a year. Molecular biology was a niche market, difficult to understand without a technical background. The team admits that at the time their view of BTF's value was much higher than that of the market. They were rapidly running out of money. Just as they thought they had found an investor and were ready to finalise the deal, the terrorist disaster of September 11, 2001 happened, causing the bottom to drop out of the market and necessitating the search for investor funds to start again from scratch.

McCloud eventually moved on, but Vesey and Gauci, as entrepreneurial scientists, were passionate about their product and were much more able to "sell the story". Almost on the brink of bankruptcy, they made contact with a venture capital firm that provided critical development funds of $2 million, enabling the company to complete their R&D program and begin to look for sales in the bacterial industry.

Using funds made available by the venture capitalist, they were able to build on their IP by combining the latest laser cytometry and bioparticle-dispensing technology with novel techniques in stabilising micro-organisms. In 2003, the company was able to announce the completion of the first of its EasySeed Bacteria prototypes, utilising its unique Bioball platform technology. This process provided the opportunity to eliminate the inherent variability and labour intensive processes from microbiology, and allowed the team to deliver the technology to applications in the lucrative food, pharmaceutical and clinical testing markets.

(iii) Manufacturing challenges

The partners found that the challenge of growing a company in this industry was the commercialisation side of the innovation, rather than technical challenges. Getting the invention to market necessitated undertaking correct labelling, obtaining approval from the correct regulatory body, arranging shipping, making sure the product had stability and a suitable shelf life with market credibility, and issues of marketing and charging the right price.

BTF found that while many people offered to help with the commercialisation process, few had actual market experience. Gauci considered that business people and scientists took a different approach to their work. The different professional value systems were often difficult to overcome. Furthermore, issues of human resources management and changing the company's cultural perspective from a technical to a commercial approach needed to be resolved. In attempting to make this shift, BTF lost some valuable staff and their associated expertise.

Another major difficulty for the company was choosing between alternative opportunities that the technology had made possible. Gauci emphasises that financial management was critical throughout all growth stages. Appropriate research directions for the company needed to be identified. For instance, in 2001 BTF was successful in gaining a Strategic Partnerships with Industry Research and Training (SPIRT) Scheme grant for a total project value of over A$7 million for collaborative research projects with the University of Technology Sydney (UTS), Prince of Wales Hospital and the University of NSW. The objectives of the collaborative work would produce excellent opportunities in DNA testing but the team chose not to pursue that opportunity, since it would stretch their resources too thinly with possible disastrous outcomes.

(iv) Company structure and commercial expertise

The venture capitalist provided commercial expertise, a board was installed to oversee development and provide commercial advice, and a marketing expert with Northern Hemisphere experience was recommended and hired. His employment enabled a major shift in the cultural focus and assisted with achieving the attraction of some major new

customers such as the US army and Nestlé, dramatically improving the company's financial prospects. The company remains a private company; however, the venture capitalist is very keen to go to an IPO and this is planned to take place in the near future.

The current growth in the firm's sales and its pipeline of products is confirmation of the founders' perceptions about the opportunities residing in the company's unique technology in 1999. Although the company has always had customers, they have been able to maintain revenue growth at approximately 38% per year. A transcendent knowledge base has laid a lucrative foundation in food and pharmaceutical testing, and there are solid prospects for diversifying into molecular testing in the future. They have not yet reached break-even point, although market analysts consider they are very close, and therefore the company remains in the Resource Mobilisation Phase.

Summary of Resource Mobilisation Phase

This phase of BTF's growth as prescribed in the methodology has been viewed through four elements: commercial expertise, long term financial and manufacturing issues and organisational structures. Table 5.19 summarises BTF's Mobilisation Phase, as discussed in this section.

Critical Problem	What kind of business model? How to have access to research papers and commercial results? How to find start capital? How to maintain a steady source of finance? Where to find R&D funds for new product? Where and how to market the water products? How to structure the company for new products?
Critical Activity	Use colleagues and mentors for assistance with business plan. Use mentor's assistance with commercial space and expertise Seek available government funding for start funds Lease manufacturing premises from mentors Manufacture and with direct marketing strategy to save money, sell water products on global market Find willing Venture Capitalist for development funds Continue research to extend unique technology Manufacture and market bacterial products on global market Restructure company with VC assistance Extend customer base to include major global stakeholders in bacterial market
Solution	Finding support financial resources from available sources Restructure business plan Streamline marketing strategy with expert assistance Maintain R&D program for extension of products. Manufacture and market bacterial products on global market

Table 5.19: Summary of Resource Mobilisation Phase – BTF

5.4 Proteome Systems Limited

Proteome Systems Limited (PSL) is a proteomics technology, diagnostics and discovery company. With its technology partners, PSL has developed and commercialised ProteomIQ™, a comprehensive solution for high throughput proteomics. These technologies, integrated by a proprietary and sophisticated bioinformatics system, BioinformatIQ™, are being marketed as part of a global strategic alliance with IBM and other corporations such as Shimadzu Corporation of Japan, Sigma-Aldridge, Millipore Corporation, Termo-Finnigan, Alpha Innotech, Kratos and IBM Life Sciences. The business is a business–technology interface with a global technology platform jointly controlled by several companies.

The case study is compiled from publicly available material and five personal interviews. Publicly available material included the company website, analysts' reports and newspaper reports. Interviewees included Professor Keith Williams, first CEO of PSL; Jenny Harry, Executive Director and Head of Discovery & Diagnostics; Andrew Gooley, Chief Scientific Officer; Nicole Packer, Head of Glycoproteomics; and Felicity Carter, Human Resource Management. Full details of the case study are presented in Appendix 4.

5.4.1 Resource Access Phase

As specified by the methodology, this section of the case study focuses on the discovery component of the value chain where activities comprise idea generation, idea evaluation, feasibility of concepts and proof of principle. It identifies numerous problems of matching the opportunity of establishing a proteomics business with integrated platforms that span the length of the protein analysis chain, with the resources to realise the opportunity. The Resource Access Phase is viewed through four elements: the entrepreneur, the technology, the environment and the financial constraints faced by the company. By finding solutions to the problems throughout this phase, the entrepreneurial scientist, Keith Williams, was able to take his initial idea to proof of concept and commercial feasibility and progress the project into the Mobilisation Phase of growth.

(i) Entrepreneur

Keith Williams, the chief founder of PSL, is a leading scientist in the relatively new field of proteomics. After returning from the Max Planck Institute of Biochemistry in Germany he took up a Chair in Biological Sciences at Macquarie University in the early 1980s. Shortly after taking up the post, he became a principal in the biotechnology firm, Australian Technological Innovation Corporation (ATIC), where he began to develop a keen interest in the commercialisation of scientific projects. He attracted Dow Chemical's interest with a view of the corporate giant taking over the ATIC program and making it a commercial success. A characteristic that Williams has demonstrated many times over the years is his ability to attract high calibre partners keen to collaborate in his projects.

The other ATIC principals vetoed his efforts with Dow Chemicals on the grounds that it was too early to form such an alliance and the corporate giant was too big to be a partner. Williams saw himself being excluded from the deals made by his commercial colleagues and frustrated that the true commercial potential of his ideas was being lost. The loss of such opportunities impacted negatively on the commercially orientated scientist and was instrumental in developing his need to influence commercial outcomes of his protein research as he eventually did at PSL.

Throughout the 1980s the study of genes progressed to a worldwide effort to map the Human Genome. As the Human Genome project drew to a conclusion, Williams and a group of faculty and student researchers studying basic cellular and metabolic issues were being drawn to the new field of proteomics. They considered that the study of proteins, not genes, would give an understanding of diseases and how they grow and develop in the human body. One of his students, Dr Marc Wilkins, then a PhD student in Biological Sciences at Macquarie University, coined the name Proteomics. The term describes the study and application of PROTEins expressed by a genOME.

Bio-informatics is where biology and computing meet and as a result of the mapping of the Human Genome, the science community had seen major improvements in technologies that store, interrogate, organise and interpret biological information. Proteomics created a greater challenge than genomics in terms of computational

problems, analysis of gene expression at the mRNA level, whole organism phenotyping and disease relationships.

The solution to these challenges was multi-layered. Williams and his team understood the need to develop laboratory instruments and supplies, and design and manufacture laboratory services and informatics such as databases and software, before the group could begin the financially rewarding development of diagnostics and drugs. To begin the program, Williams established the Macquarie University Centre for Analytical Biochemistry (MUCAB) in 1992 as a way to focus on the possibilities of improving instrumentation and to facilitate a process that Williams describes as "industrialising protein analyses". However the cost of such a plan was well beyond the faculty's immediate resources.

The solution to this possible obstacle came at the end of 1995, when Williams and his team won funding from the Australian Government's Major National Research Facility. The funding of A$7 million provided an opportunity to set up an advanced facility in protein research. The Australian Proteome Analysis Facility (APAF) became the world's first proteomics facility funded by a national government. A further A$5.6 million R&D grant followed for the development of new instrumentation for high-throughput protein studies. This centre became one of the largest in Australia and drew global attention to the new interest in proteins. It also provided an opportunity for Williams and his team to further develop their expertise in informatics and technology development in the field of proteomics.

Throughout 1997–1998, Williams saw the threat of his team being poached by corporations around the world for their expertise. It was decided that forming a company was the best way of keeping the team together and the group entered into negotiations with the university with the intent of forming a commercial venture. Negotiations continued for a year with no progress, so Williams and his team moved out of the university and formed their own business. Table 5.20 summarises the entrepreneurial market aspirations of PSL's scientific entrepreneur, as outlined above.

Critical Problem	How to use ten years of research experience to build on a scientific idea? How to build a team of experts in protein analysis? How to keep experts from accepting job offers from overseas competitors? How to convince conservative scientific community of the benefits of commercialising the research?
Critical Activity	Use position as Head of Ontology at Macquarie University to promote a scientific idea Gather group of faculty and student collaborators to study basic cellular and metabolic issues. Inspire leading students to coin name for new idea Promote research efforts of team to external stakeholders so as to develop a biochemistry centre at Macquarie University Promote research to attract government funding to establish a proteome analysis facility
Solution	Build and retain solid core team of faculty colleagues and students to become experts in the revolutionary new field of proteomics research Establish Centre for Analytical Biochemistry at Macquarie University (MUCAB) in 1992 Establish Australian Proteome Analysis Facility at Macquarie University with government funding Maintain commercial perspective

Table 5.20: Resource Access Phase entrepreneurial challenges – PSL

(ii) Technology

There are about 35,000 genes but about 500,000–1,000,000 proteins. Those proteins that could be drug targets are available only in tiny quantities and thus are difficult to analyse. Proteins also change in response to variations in the cellular environment. In the late 1980s conventional techniques for protein analysis were laborious, non-standardised and prone to contamination, providing unreliable or not easily reproducible data. To achieve a sound understanding of protein function, the whole process needed automating. But commercial information management systems were not available to facilitate proteomics automation efforts. Software would also need to be developed to handle the huge amount of data from mass spectrometers that were used for protein identification. Further software would need to be developed to allow automated image

analysis of the protein spots on gels in order to archive, compare and determine the differences between samples.

Williams recruited a former student, Andrew Gooley, to head a group developing the required tools for automation, robotics and integrated systems for proteomics. The team developed instruments for protein sequencing and for automating the process of cutting out protein spots from gels. Gooley had been working on protein analysis steps and came up with the idea for a chemical printer, an idea that would later become central to the group's commercial efforts. The idea was filed as a provisional patent with Macquarie University holding the intellectual property rights. Table 5.21 summarises PSL's technological challenges, described above.

Critical Problem	How to automate conventional techniques for fast protein analysis to produce reliable and easily reproducible data? How to develop software to handle the huge amount of data from mass spectrometers used for protein identification? How to develop software to facilitate automated image analysis of the protein spots on gels to take place so as to archive, compare and determine the differences that exist between samples?
Critical Activity	Take multilayered approach to develop the various stages of the technology Work first on developing laboratory instruments and supplies then move to the development of laboratory services as well as informatics including the design and manufacture of databases and software Develop new idea for a chemical printer and file provisional patent with the university
Solution	Recruit ex-student to head group to develop tools for automation, robotics and integrated systems for proteomics including chemical printer Develop instruments for protein sequencing & automating the process of cutting out protein spots from gels

Table 5.21: Resource Access Phase technological challenges – PSL

(iii) Financial resources

Mapping of the human genome provided the initial dawning of the possibilities with proteomics. Williams and his team of research students used laboratories, equipment and research facilities that were available to them through their association with the university. Salaries were paid by the university and the focus was on solving technological problems, not making financial returns.

Funding of A$7 million from the Australian Government and a A$5.6 million R&D grant, described above, assisted the fledgling company's finances. However, Williams found that forming a company while his team continued to operate within the university environment was difficult. Despite the assistance of corporate lawyer John Martin, of legal firm Allen, Allen and Hemsley, and prominent company director Bruce Hogan, negotiations with the university dragged on for a year.

Critical Problem	Where to find funding for expensive research and instrument development? How to establish a protein analysis facility with funds that are beyond the capabilities of the university?
Critical Activity	Use senior position at university to attract funding for the establishment of a centre for microbiology research Respond to federal government invitation for applications for funding to establish a major national research facility
Solution	Use university facilities provided with university funding to progress research Succeed in attracting $7 million federal government grant to establish the Australian Proteome Analysis Facility (APAF) which became the world's first proteomics facility funded by a national government in 1995 Succeed in attracting additional $5.6 million government to the development of new instrumentation for high-throughput protein studies in 1996

Table 5.22: Resource Access Phase financial challenges – PSL

During this time the group had also entered into a dialogue with Dow AgroSciences (DAS), a large agricultural biotechnology company keen to collaborate with the group.

DAS was reluctant to begin the project while the team was at the university, fearing a lack of commercial focus. On Christmas Eve 1998, the dialogue with the university broke down and Williams and key members of his group resigned from the university. Table 5.22 summarises PSL's financial challenges during the Access Phase.

(iv) Environment

In the early stage of proteomic development, when problems were not clearly understood and effective processes were still to be defined, ideas for the best direction to take were very diverse. Some companies were focusing on developing integrated platforms that spanned the length of the protein analysis chain, others on specific stages of protein analysis. There was, however, no consensus on which stage of protein analysis needed greatest attention or which technology was the most appropriate. While PSL had identified the sample preparation and data analysis steps as important bottlenecks, others viewed the mass spectrometry stage as a key block that could be overcome by using tens or hundreds of mass spectrometers. Still others cited the inability of the 2DE protein separation technique to allow adequate relative quantification of the protein levels between samples. These companies had developed alternative techniques such as Isotope Coded Affinity Tagging (ICAT) that allowed better relative quantification and concurrent identification. The ICAT technique, however, also suffered limitations since it did not address protein modifications, an area that PSL considered essential for comprehensive protein analysis. Some companies combined the two methods while Celera's proteomics efforts, for instance, planned to dispense completely with 2DE using liquid chromatography (LC) methods for protein separation instead.

Yet others, such as Ciphergen, had taken an entirely different approach and had developed technologies that allowed users to isolate proteins according to their chemical attributes using a range of 'chips' that could then be used in a 'chip-reader' that included a mass spectrometer. Some were hoping to develop protein interaction maps that could uncover critical pathways and therapeutic targets, but most of these companies used recombinant proteins that PSL considered were not authentic. PSL also intended to address protein-protein interactions but stressed that their approach would

use authentic proteins. PSL was also focusing on tight integration of its systems with Dratos' MALDI mass spectrometer and Thermo Finnigan's LCQ LC/MS/MS instrument. The company saw its primary competitors to be Amersham Pharmaceia Biotech, its old partner at APAF, Bio-Rad, PE BioSystems, as well as the smaller Genomics Solutions. Finally, PSL was not alone in wanting to use its proteomics technologies to fuel its drug discovery programs. Companies with greater resources, such as GeneProt and Oxford Glycosciences, were already drawing attention from larger pharmaceutical companies.

Critical Problem	Very promising post genomic environment that had growing number of companies concentrating on protein analysis Well resourced competitors drawing attention from large pharmaceutical companies No defined processes for research direction therefore possible to overextend area of R&D
Critical Activity	Focus on platform for high throughput analysis of proteins Identify three tiered strategy to design and develop instruments that will then assist with diagnosis and research that will then assist with the manufacture of drugs to cure various diseases Build team of experts across the three tiers Use university and government financial support to establish and develop research Build industry networks to seek additional partners as possible sources of expected additional funding
Solution	Make APAF the largest Australian centre attracting global attention to the new interest in proteins Demonstrate superior skills and knowledge of expert team through product development such as chemical printer Negotiate with university for corporatisation of R&D program

Table 5.23: Resource Access Phase environmental challenges – PSL

The company, therefore, was not alone in the proteomics field. In the post-genomic era many companies with far greater resources than PSL were moving into the field. Williams surmised that the first proteomics group that could demonstrate high throughput analysis of proteins would attract the attention of the big pharmaceutical companies. However, given the competitive environment, it was always possible that

any company would only be able to claim part of the prize and the market for PSL technology may have been smaller than the team had expected. Table 5.23 summarises PSL's environmental challenges in the Access Phase.

Summary of PSL Limited Resources Access Phase

The Resource Access Phase of PSL's growth path has been viewed through four elements: the entrepreneur, the technology, financial resources and the environment. The elements are interdependent and their interaction has contributed to a successful outcome for this phase, where unique knowledge in the new field of proteomics has assisted the development of unique instruments to assist with a proposed 3-tiered development program. To incorporate the IP of his team of experts, Williams had intentions to progress the project to the Mobilisation Phase by forming a company, PSL.

5.4.2 Resource Mobilisation Phase

This phase of the case study, as set out in the methodology, revolves around the conversion of assets that have been assembled in Phase I to generate resources. It focuses on the development of leading IP and instrumentation successfully developed at the university to progress the company's R&D through a 3-tiered strategy for the lucrative development of drugs for the relief of various diseases. The five elements that make up this phase include the development of business plans to attract business expertise, solving long-term financial and manufacturing issues with major partners and building appropriate organisational structures so as to enable the company to reach break-even point and begin to make profits.

(i) Developing an appropriate business plan

PSL began Phase II with access to only one resource, the intellectual property that resided in the brains of its co-founders. However this was no lightweight group. The six academic founders of PSL had complementary strengths and skills that were critical to

the strategic plan of the company. Williams is a biological scientist, his Chief Scientific Officer had experience in instrument and application development, being responsible for pioneering the use of piezoelectric micro-dispensing in proteomics. Others had experience in glycobiology and biochemistry, cell and developmental biology, protein separation, experience in directing collaborative projects with industry partners and the coordination of proteomic research projects. Williams demonstrated great leadership skills in giving the whole group the confidence to move out into an uncertain market despite potential financial and career failure. They were convinced that they understood the genetics and had the diversity of skills to be successful.

Williams was also able to draw to the company some very valuable resources in the form of commercial capabilities that filled skill gaps in the group. John Martin, who had been a chief negotiator for the group with Macquarie University, left the law firm and became full-time deputy CEO of the company. The law firm continued to provide legal advice; additional advisers were PricewaterhouseCoopers as auditors and F.B. Rice as patent attorneys. The company's Board also included Bruce Hogan, with 15 years' experience at Bankers Trust, where he retired as Managing Director, who provided a solid commercial knowledge resource. Laboratory space was leased from Peptech, another Australian biotechnology firm that had reduced its laboratory space requirements in North Ryde, a Sydney suburb close to Macquarie University. The space was already fitted for laboratory use and perfectly suited the new company's needs.

PSL's initial business strategy was viewed by Williams as firm growth through what he described as 'three horizons'. The plan was for the relationship with Dow AgroSciences (DAS) to provide immediate cash (the first horizon) that should sustain the company while they developed the second horizon of the protein technology hardware that would eventually drive the third horizon, a drug discovery program. This final horizon was expected to enable the company to ultimately become a pharmaceutical company without the need to sell out to overseas interests. Through the first year of its existence, this business model provided the growth direction for the start-up company.

(ii) Long-term financial resources

When PSL was formed, 100% ownership was to remain with the founding six members, plus Hogan and Martin. It was not necessary to obtain short-term or medium-term capital at the outset, since the 1999 partnership with DAS provided funds to run the business and get it started. DAS invested heavily into a multi-layered agreement with PSL to boost its own efforts in pest management and the alteration of food plants. The relationship was a success. PSL surpassed expectations and met all its milestones with DAS at the end of the first year. In February 2000 DAS extended the agreement for another year. Unfortunately, world-wide debate and negative public sentiment toward genetically engineered crops led DAS to end the collaborative venture.

Although defunct after a short time, a major contract with a corporate giant such as DAS provided PSL with some excellent references. PSL had clearly demonstrated that it could maintain a successful relationship with a corporate giant. First, it showed that the start-up company could deliver services of value to a multinational, on-time and on-budget. Second, it maintained the company in a positive cash flow for its first year, relieving pressure on the financial front so as to avoid the pressure of VC funding. Third, it gave PSL an important reference group who were impressed with the expertise of the founders. Finally, it gave PSL insight into the needs of proteomics discovery companies, sharpening awareness of the need for adequate fast throughput instrumentation.

(iii) Manufacturing issues

PSL understood that they were operating in a highly competitive and complex market. They also understood that they had neither sufficient financial resources nor the manufacturing skills that would assure speedy development of the innovative technology they were aiming to produce. Their strategy therefore was to work in partnership with groups or companies with these skills while PSL would contribute their protein knowledge. The first such partner was Shimadzu Corporation, a Japanese company with a long history of manufacturing scientific instruments with recognised skills in the manufacture and marketing of analytical instruments, medical instruments

and mass spectrometry through its ownership of Kratos Analytical. Products developed and manufactured by these two partners included a patented product for protein identification, and the Xcise and software development for Kratos' AXIMA mass spectrometry proteomics applications. The major development in the partnership was the second instrument, a chemical printer that had been patented by Andrew Gooley for Macquarie University. In November 2000, PSL had acquired from the US firm MicroFab Technologies the right to use the "matrix jet" technology for squirting minute quantities of chemical reagents. In addition, key patents had reverted from the university to Gooley as the inventor. Thus by December 2000, the partnership was able to announce a major milestone involving the development of membrane-based printing protocols for peptide-mass fingerprinting applications.

PSL, in partnership with MicroFab Technologies, developed a third instrument called the PiezoLC. This was similar to the chemical printer except it had a miniaturised chromatography system for preparing protein samples for mass spectrometry. The technology would also allow the company to enter the protein 'chip' market by 2002. In the process, in March 2001, the company had forged an alliance with the Millipore Corporation, a dominant player in the membrane field. PSL adapted this technology for its platform and also developed kits to clean and concentrate protein samples to use in the mass spectrometer.

In late 2001, Williams demonstrated beyond any doubt his skills in creating and fostering partnerships by forming a global strategic alliance with the corporate giant IBM. PSL considered that partnerships were absolutely essential to the way they did business. The company strategy was to develop everything with partners, except for the big technology platform, which it would sell. The alliance with IBM elevated the small Australian life science company into an elite group of only 70 companies worldwide with which IBM had strategic alliances at the time. PSL's success in convincing corporate giants such as IBM, Shimadzu, Sigma-Alldrich, Millipore and others to not only provide $68 million to fund hardware development, but to also become joint venture partners in the projects, demonstrated its effectiveness and greatly enhanced its credibility for several years. These activities also provided much-needed cash for further development of the 3-tiered business plan. The progress the company was

making convinced the company directors that their business plan was sound and would provide solid returns.

(iv) Company structure and commercial partners

The US remains the world's largest biotechnology market. PSL considered that companies desiring to compete in this industry needed to establish visibility and credibility by dealing in the US market if they were to survive globally. Williams felt that the company needed a base in the US and in October 2000 announced the opening of a proteomics factory in Boston. It was expected that PSL's Boston factory would allow the company to have a demonstration and training facility to showcase its proteomics technologies and the kits and consumables would be manufactured there because of problems with shelf life.

In the period June 2002 – June 2003 it became necessary to totally restructure the Boston operation. The company had moved from a small business focused on consumables manufacturing, to an enterprise focused on sales, marketing and customer support. The original Boston group, with a science culture, did not meet this need and eventually many of them left the company. The timing, however, was fortunate because PSL's partner, Millipore, was restructuring. Millipore's president of life sciences, Bill Enhiser, who drove the proteomics initiative, left Millipor and joined PSL in Boston, bringing local knowledge and connections within the US market with him.

Although the company's leading IP provided it with competitive advantage, its sales team was limited. Such a shortage required the founders to be IP developers, sales agents and marketing experts. By 2001 scientists who understood the technology were required to shift into other priority areas so that they could go from a developmental program into a validation and installation team. Although the company was achieving excellent results, personnel found such constant changes and the thinly stretched resources very onerous, especially when returns were not as forthcoming as promised.

Other problems began to surface as the company grew in size. Williams was adamant that scientists could be good business managers. He considered running a successful lab required similar skills as running a small business, since many of the issues – juggling

cash flow, people skills and project flows – were similar. The rapid pace of events forced the company to realise that it needed an external evaluation of its management structure. Williams was convinced that the structure should remain very flat, which had been appropriate when the company first started with 15 people. By the end of the first year there were 30 people working in the company, rising to 80 by the end of the third year and 90 by the end of the fourth year. PSL employed the services of HR consultant, Felicity Carter, to take the company vision and create an infrastructure that would work to maintain the synergy between the four facets of the company.

She soon identified that although top management continued to understand the direction of a particular project, as the company had grown, employees further down the scale were often not sure who they were directly accountable to. People were unsure whether they worked for a technology company, a discovery company or another research company. Objectives were no longer clear. Carter introduced a regular survey she called "change tracking" to monitor the emotional side of the organisation that impacted on business performance and on the culture that the company was building. This proved to be effective but additional problems surfaced.

PSL's alliances with partners had generally concerned the sharing of technology; PSL had the knowledge and the partner brought related production capability. In the first few years PSL was more interested in the cash flow and finding a partner to help fund the development. But as the company's development progressed, focus changed to new strategies to assist with downstream problems. Shimadzu did not provide the expected sophisticated marketing capabilities, which was also PSL's weakness. PSL engaged David Jacobs, who ran the Australia Japan Link as a Japanese local consultant. In 2003 as tension rose around PSL's frustration with their Japanese partner, Jacobs became much more closely involved with the company's Japanese business strategy. He was instrumental in starting the long process of resurrecting the relationship, demonstrating to PSL that the Japanese and the western definition of relationship were two very different things. The lesson for the company was that it couldn't necessarily assume that after two or three years its relationship with partners would be positive; rather, constant management was needed.

The difficulties that eventually need to be confronted are seldom recognised in initial business plans. The 3-tiered, long-term approach certainly confirms the founders' drive

for internal growth. There was, however, a flaw in the plan which was demonstrated when the privately-owned company attempted to go to an IPO in 2004.

PSL, as the world's leading producer of instruments in proteomics, had demonstrated its superior capabilities by winning several global awards for its technology. It had spent large amounts developing the technology for the research. However, after it had invented the technology, few customers needed to buy it. Therefore, although the company was able to generate $41 million revenue in the four years to June 2004, it incurred losses totalling $61 million. This negative position meant that PSL went into the float with a deficiency of $234,000 and an operating cash flow that was running negative at nearly $20 million a year. The market did not respond positively. The company raised only $20 million of the expected $45 million and its market value consequently dropped from $250 million to $120 million. By March 2005, the firm had already used $12.5 million of its $20 million float cash.

Williams was replaced as CEO in April 2005 by Stephen Porges. The new CEO noted that the "long term opportunities for the business were not where the money was being spent. It was a flawed business plan". However, no-one had suggested Williams's initial plan in 1999 was wrong. Until the float in 2004, accolades of praise were heaped on Williams and his team, noting that this was not only an extremely innovative product development strategy but also a revolutionary and successful strategic plan. Endorsement of corporate giants was seen as substantiating such claims. However, Porges has added that the trouble with scientific entrepreneurs is that "they get so wedded to the science of the science that they forget the importance of the shareholders. This means trying to get a return on the business and sometimes it is hard for scientists to see that".

Proteome Systems Limited is an Australian company that took a very big step into the global market. Evidence of its outstanding intellectual property has been demonstrated through the partnerships it was able to form in its six-year history and the awards it received. It is still a major operator in the market with strong prospects; however, it has still not reached break-even point and remains in the Resources Mobilisation Phase.

Summary of Resource Mobilisation Phase

Critical Problem	What kind of business model? How to best compete in a highly competitive market? How best to convert the tacit knowledge in the brains of the cofounders into commercially viable IP? How to maintain a steady source of finance? How to develop the best company alliances? How best to manufacture instruments without manufacturing expertise? How to market the new instruments and consumables? How to establish a global presence? How to stretch and extend available knowledge base of scientists beyond their research capabilities so that they could be instrumental in sales and installation projects. How to best structure the growing company? How to maintain synergy between various facets of the company as its activities expanded? How to manage growing problems with established partners? How to access additional funding required to ensure the development of the three horizon business plan? How to survive an unsuccessful IPO listing?
Critical Activity	Form commercial relationship with corporate giant, DAS to meet immediate cash needs Acquire the right to use competitor technology and reclaim patent from university Form partnership alliance with Shimadzu Corp to address lack of manufacturing and marketing know how Form additional partnerships with global giants such as IBM to manufacture and market new products as they were developed Purchase a subsidiary company to establish US presence Employ resources to coordinate HR issues Employ consultant to coordinate cultural issues with partners Go to an IPO Re-valuate company strategic direction
Solution	New leader Restructure business plan Restructure company Streamline research focus Build networks to assist with clinical trials for drug development

Table 5.24: Summary of Resource Mobilisation Phase – PSL

This phase of PSL's growth has been viewed through four elements: commercial expertise, long term financial and manufacturing issues and organisational structures. The company has still not achieved break-even point and therefore remains within the Mobilisation Phase. Table 5.24 summarises PSL's mobilisation challenges, as discussed above.

5.5 Cotton Seed Distributors

Cotton Seed Distributors (CSD) is a cotton growers' cooperative formed to provide the best available seed for the cotton growers' market. The company was formed in 1969 and has worked closely with Commonwealth Scientific & Industrial Research Organisation (CSIRO) Division of Plant Industry since 1972 to breed cotton seed that is best suited for local conditions in Australia and overseas. CSD is an example within the agricultural sector where transformations in production methods have been substantially enhanced since the 1960s through biotechnology. As an example, genetically improved crops that are resistant to the 300 pests and various weeds found in a cotton crop have dramatically reduced the need for chemical spraying, enhancing the long term viability of the industry.

The data for this case study have been gathered from five interviews and publicly available material. Interviews were conducted with Frank Hadley, Founder; Peter Graham, current CEO; Phil Steel, Seed, Product & QA Manager; T J Higgins, 2IC, Plant Division, CSIRO; Jim Peacock, recently retired from Head Plant Division, CSIRO, and now Australian Chief Scientist for the Australian Government. Publicly available material includes the company website, CSIRO website and several newspaper articles. Financial details are provided in general terms. Records such as annual reports, financial reports and minutes of meeting were not available due to the age of the company and recent loss of archival material. A more detailed discussion of this case study is presented in Appendix 5.

5.5.1 Resource Access Phase

As outlined in the methodology, this section of the case study revolves around the early establishment of a business. The Access Phase for this company focuses on the numerous problems of matching the opportunity of growing cotton in Australia with the resources to realise the opportunity. As in previous case studies, the Resource Access Phase is viewed through four elements: the entrepreneur, the technology, the environment and the financial constraints faced by the company. This firm differs in its Access Phase from those presented above in that routines and procedures were already

known by the two entrepreneurs. In the first four firms, development issues were a trial and error process as the firm moved down the value chain. In CSD, such knowledge resources were already available to the two entrepreneurs, who had grown cotton in another country. Such knowledge may have contributed to lessening of some growth problems that this company faced during its original phase.

(i) Entrepreneurs

The catalyst for the industry stems from government subsidies offered to growers in an effort to reduce Australian dependence on imported cotton in the 1960s. Frank Hadley and Paul Kahl have been acknowledged as the founders of the cotton growing industry in northern NSW. Hadley was born and raised in Merced, California, in a farming family and had been in the cotton growing business all his life. Cotton growing became unprofitable in California during the 1950s giving Hadley and his friend Kahl the impetus to undertake a short exploratory trip to Australia in March 1961 to investigate the Australian Government's subsidy offer. After considering several sites, the two farmers chose the Naomi River as the best area to begin farming cotton. There was no commercial cotton in NSW at the time and no irrigated cotton in Australia but the promise of high subsidies was very attractive. The irrigated cotton growing efforts of the two Californian farmers proved to be successful and encouraged neighbours to convert to growing cotton, thereby creating the fledgling NSW cotton growing industry in 1962. Cotton Seed Distributors (CSD) was established in 1969 by the two pioneers to find the right kind of varieties of seed for the Australian cotton grower as the industry began to expand. Table 5.25 summarises these entrepreneurial market aspirations of CSD entrepreneurs.

Critical Problem	Is it possible to transfer knowledge of the Californian cotton growing industry to Australia? Where is the best potential to grow cotton in Australia? Will government promised subsidies provide the impetus to establish a cotton growing industry? How to find the best cotton seed for Australian growing conditions?
Critical Activity	Travel to Australia in 1961 to undertake an exploratory trip Choose Naomi River as the most appropriate growing area with the best potential for growing irrigated cotton Demonstrate through successful farming practices that cotton farming can provide a profitable enterprise to entice neighbours to join in establishing a fledgling industry in 1962
Solution	Join with neighbours to form a cooperative to research for the right kind of seed for Australian conditions in 1965

Table 5.25: Resource Access Phase entrepreneurial challenges – CSD

(ii) Technology

The fundamental aim of the CSD cotton seed breeding program is that new seed releases will produce larger benefits for growers than the varieties they replace. From the time that the initial cross of two desirable parents is carried out, it generally takes 8–10 years before a new variety is commercialised. Steps in the development of a new conventional variety include crossing of selected parents; making plant selections; testing unreplicated progeny; planting replicated progeny in rows (1–2 sites); preliminary lines trials (3–6 sites); advanced line trials (13 sites); and CSD large scale commercial trials. The seed cotton is weighed on site, before sub-sampling for gin turnout and fibre quality analysis at the Australian Cotton Research Institute.

Testing involves a wide range of locations and decisions, as the suitability of a line for a location is based on performance at that location. At each step of the process, lines showing poor seedling vigour, disease susceptibility, poor fibre quality or low yield are eliminated from the program by the cotton breeder. The final stage in the breeding process before commercialisation of a new variety is assessing its performance under commercial growing conditions, in CSD large scale trials. Currently the varieties for

inclusion in each CSD trial are decided upon in a joint meeting between CSD agronomists and a CSIRO cotton breeding team; however, in its initial stages the process was undertaken by members of the original cooperative.

The two Californian farmers and their neighbours formed a cooperative cotton gin in Wee Waa with Kahl as chairman. About a dozen growers joined the cooperative and in the third year Ozcott Pty Ltd, a US subsidiary of JT Boswell, also joined the operation. For the first few years the planting seed was processed by the cooperative. Mechanical saws were used to get the lint off the planting seed but they were not very efficient. Therefore in 1965, the cooperative installed a delinting plant, and CSD was formed to facilitate the business side of the operation.

Table 5.26 summarises CSD's technological challenges in the Access Phase of its growth.

Critical Problem	How to develop a new commercially viable variety of cotton seed for Australian conditions? How to have time to devote to research over a wide range of locations with varying quality, vigour, disease susceptibility and fibre while acting as farmers?
Critical Activity	Cooperate with neighbours to begin the long process of selecting the best seed varieties for the region
Solution	Establish cooperative to raise funds for research and development of best seed varieties Form a company to facilitate the business side of the cooperative operation

Table 5.26: Resource Access Phase technological challenges – CSD

(iii) Financial resources

The cotton growing members of the cooperative contributed the initial capital to CSD, with extra financial support provided by the Naomi Cooperative, Queensland Cotton and the Westpac Bank. The growers put up their own guarantees as security for the loan. The capital was used to establish a plant and several breeding stations to test for the best varieties of cotton seed. The seed increase and development program was, and

continues to be, supported by a ginning and baling facility. The commercial plant continues to provide integrated receival, storage, delinting, chemical treatment, dispatch, laboratory and workshop facilities, supported by on-site administration. The final product is distributed around the country through partnerships with distributors. Table 5.27 summarises CSD's financial challenges in its Access Phase.

Critical Problem	How to raise sufficient capital to carry out research and provide linting and ginning facilities for the fledgling cotton growing industry in Australia?
Critical Activity	Cooperate with neighbours and other cooperatives to raise capital and provide personal guarantees to form company to carry out administration and business aspects of the process
Solution	Establish CSD to facilitate the business of growing irrigated cotton with government subsidies in Australia

Table 5.27: Resource Access Phase financial challenges – CSD

(iv) Environment

Hadley and Kahl entered the cotton growing industry at a fortunate time. The federal government had promised subsidies for farmers to convert to cotton growing in an effort to reduce what it perceived as an alarming increase in cotton imports. The philosophy of the day was for the country to be as self-sufficient as possible in terms of primary industry products. The demand for cotton on the domestic market was well established, and the government provided assistance through subsidies and tariff protection. Furthermore, the two Californians were familiar with the principles of cotton irrigation and were well suited to leading the Australian irrigated cotton-growing industry because they already had the farming skills, appreciated the importance of climatic and soil conditions, and understood industry processes. The CSD cooperative was a replica of the Californian counterpart. Table 5.28 summarises CSD's environmental challenges in the Access Phase.

Critical Problem	How to best use the government offer of subsidies to establish a business for cotton growers?
Critical Activity	Use skills and knowledge from California to underpin the development of the cotton growing industry in Australia
Solution	Establish CSD to facilitate the business of growing irrigated cotton with government subsidies in Australia

Table 5.28: Resource Access Phase environmental challenges – CSD

Summary of CSD Resource Access Phase

The Resource Access Phase of CSD's growth path has been viewed through four elements: the entrepreneurs, the technology, financial resources and the environment as prescribed in the methodology. The elements are interdependent and their interaction contributed to the successful establishment of a business to provide the best cotton seed variety for a fledgling cotton growing industry in Australia. The experience the two farmers brought to the venture provides evidence of the benefit of inherited resources such as routines and knowledge of appropriate processes. In contrast to the first three case studies, there was no need for a crossover phase and the firm began to its accessed resources with relative ease.

5.5.2 Resource Mobilisation Phase

This phase of the case study concerns the conversion of assets that have been assembled in Phase I to generate resources. It focuses on five elements: the development of business plans to employ commercial expertise, solving long-term financial and manufacturing issues, and building appropriate organisational structures to enable the company to reach break-even point and begin to make profits.

(i) Business plans and commercial expertise

Cotton Seed Distributors (CSD) was established in 1965 by the two pioneers as a replica of a Californian company, Californian Cotton Producers and Cotton Seed

Distributors (CCPCSD). The two Californian farmers understood the concept of a cotton growers' cooperative and were able to easily transfer the knowledge to the Australian industry, given the similarity of the growing conditions. The business plan was simple and low-risk. CSD was registered as a private company limited by guarantee and was non-taxable, falling under the Agricultural Act of 1950. It is still under that same charter and, although membership fees have at times resulted in big funds, these are all directed into improving the business and additional research.

(ii) Long-term financial resources

In 1972, CSIRO began a conventional variety cotton breeding program, centred at Narrabri. By 1976 the program had developed a local seed that was better than the overseas seed CSD was using. At this point CSD entered into a commercial arrangement with CSIRO, increasingly introducing the local cotton seed varieties, and by 1986 CSD was using the CSIRO varieties exclusively. At that stage a formal agreement was established between the two parties that included a royalty payment depending on how much seed CSD sold on a percentage basis.

(iii) Manufacturing issues

The CSD business plan continued to operate until the early 1990s, with modifications relating to the proportion of input provided between the two partners. With research costs contained by a publicly funded partner and increasing numbers of growers wanting to obtain the best available seed in a protected market, there was little need for the company to change its direction or practices, since no personal benefit could be received by the board or any members of the firm. Break-even point was reached in a few years and the company moved into its Resources Generation Phase. Table 5.29 summarises CSD's resource mobilisation challenges.

Critical Problem	How to best develop seeds suited for Australian conditions?
Critical Activity	Use the resources of a private company limited by guarantee and non-taxable in partnership with a public research institution to develop superior seeds for members
Solution	Improve conditions by directing all membership funds into improving business and additional research

Table 5.29: Summary of Resource Mobilisation Phase – CSD

5.5.3 Resource Generation Phase

Garnsey's (1998) model identifies problems throughout this phase as revolving around assimilation of new members, building key relationships with customers and distributors, and putting systems in place for effective production and market feedback. Having reached this phase of its growth soon after mobilising its accessed resources, CSD began to slowly increase its human and production resources as its membership grew. However, several changes in direction were required over time.

(i) Production issues

In the 1990s, conventional breeding programs were gradually combined with biotechnology research to produce transgenic seed. The breeding program changed direction towards a biotech focus for several urgent reasons. The first was the nature of the growing requirements of the industry. Approximately 300 pests can destroy cotton plants. A similar number of weeds reduce the ability of healthy plants to survive and produce high quality cotton. Such problems resulted in farmers spraying their crops extensively, but the increasing level of environmental toxicity meant that the industry was not sustainable. Biogenetic engineering was able to grow crops that needed minimum spraying while also improving the yield.

(ii) Company structure and commercial expertise

Changing market conditions also required a change in direction of the breeding program. While the industry operated in a protected market there was no pressure to improve or increase operations. With CSIRO input, Australian cotton seed was superior to that of many other countries and a combination of overseas sales and the domestic market continued to provide farmers with a solid income. Growth past break-even point was not a goal for CSD. Production processes became entrenched with inefficiencies and there was little need for accountability given the industry protection. For about ten years the company operated on a plateau with little growth.

A market survey in the 1990s demonstrated that Australian seed was being imitated at an alarming rate and the competitive advantage that the company had established with its superior quality seed was being eroded. The environmental toxicity endangered the industry. A new competitor, Monsanto, had entered the Australian market. For all these reasons processes needed to be overhauled.

Alliance with a global corporate partner was established to gain international commercial and legal expertise. The company was able to export seed overseas, including to the Mississippi cotton-growing region in the US. The extension of the company's activities into overseas markets required an urgent overhaul of its operations and a change in its growth focus.

These changes also brought about some major cultural changes with their own problems. The maintenance of partnerships with companies like Monsanto and Bayer demanded processes and procedures that were clearly documented. Accounting principles and organisation skills had to be best practice. Staff needed to be skilled in business competencies, and scientifically trained technicians and researchers had to be employed.

Additional changes were experienced in other stakeholder relationships. Prior to the global extension, distribution had been through Namoi Cotton, Ozcott and Queensland Cotton, and CSD knew all these distributors personally. CSD now had 72 different distributors and the market was very tight. Furthermore, new government regulations were introduced, and the company had to deal with the Office of Gene Technology

Regulator. Very stringent rules on genetically modified crops meant that the partners had to clearly demonstrate what genes were in the seed, and who owned the genes. These legal issues required sophisticated legal advice which the company did not initially have.

CSD was no longer able to operate in its traditional relaxed manner. Dealing with six different markets, handling transgenic and ordinary seed varieties, required efficient processes and people needed to be accountable. The necessary skills for maintaining this international biotechnology business have expanded and the company has been forced to make a major cultural shift in its structure, processes and human resources. Its continued survival and growth will depend on its ability to meet these challenges. Table 5.30 summarises CSL's resource generation challenges.

Critical Problem	How to reduce environmental toxicity created by spraying needs that were leading to a non sustainable industry? How to increase production and administrative efficiency to remain commercially viable? How to extend possible market penetration? How to improve services to meet requirements of participating on global markets?
Critical Activity	Increase transgenic seed that requires minimum spraying Overhaul production and administrative methods Develop partnership with global partner Provide services to overseas market
Solution	Become a global company with highly efficient processes in place

Table 5.30: Summary of Resource Generation Phase – CSD

5.6 Chapter summary

This chapter has presented case studies of five Australian biotech companies. The companies are diverse in their operations. Cochlear Limited is a medical device company whose cochlear implant enables a profoundly deaf person to hear. Novogen Limited is a drug development company addressing major human degenerative diseases. BTF is a supplier of precision microbiological testing solutions for water quality, among others. Proteome Systems Limited (PSL) is a proteomics technology, diagnostics and discovery company involved in the study and application of proteins expressed by a genome. Cotton Seed Distributors (CSD) is a cotton growers' cooperative involved in producing high-quality cotton seed, including genetically improved crops.

The chapter has described how each of the cases dealt with the particular problems encountered during the first three early growth stages outlined in the Garnsey (1998) model: the Resource Access, Resource Mobilisation and Resource Generation phases. The following chapter compares and contrasts the experiences of these five companies with the typical growth stages of the model.